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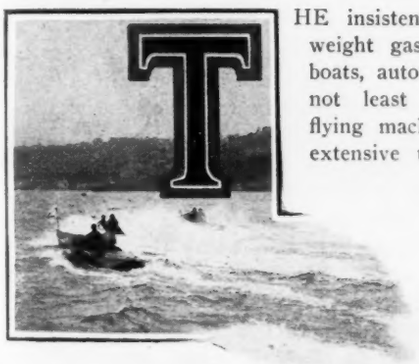
THE FOUNDRY

Vol. 36, No. 2 | Cleveland, Ohio, April, 1910 | Whole No. 212

ALUMINUM GAS ENGINE CYLINDERS

Their method of production and a discussion of how the shrinkage problem was overcome in the foundry



THE insistent demand for light weight gas engines for motor boats, automobiles and last, but not least in importance, the flying machine, has led to the extensive use of aluminum in the construction of these motors. Cylinder heads, pipes, frames, etc., are now cast of this wonderful white metal, but the cylinder for many years resisted the efforts of the engine builder when aluminum was tried as a substitute for gray iron. All experiments with aluminum cylinders have failed, as this metal wears away rapidly as the result of the piston travel, and good compression cannot be maintained. Efforts were made to insert gray iron liners in aluminum cylinders, which were made about ½ inch over-size and were reduced to the proper dimensions by the cast iron sleeve for the piston travel. As it was found impossible to obtain a perfect fit of the liner to the cylinder under all conditions, chiefly due to the variations in the shrinkage of the two metals, these experiments were not marked with success. Some builders then attacked the water jacket, and by reducing the thickness of the metal, replaced iron with copper and thereby cut off a few pounds from the total weight of the engine.

With a full knowledge of the many failures that have been recorded in recent years in endeavoring to solve the aluminum cylinder problem, it was maintained by Edward C. Ewen, president and general manager of the General Machinery Co., Bay City, Mich., that an aluminum cylinder lined with a stronger metal for piston travel and wear, was not among the

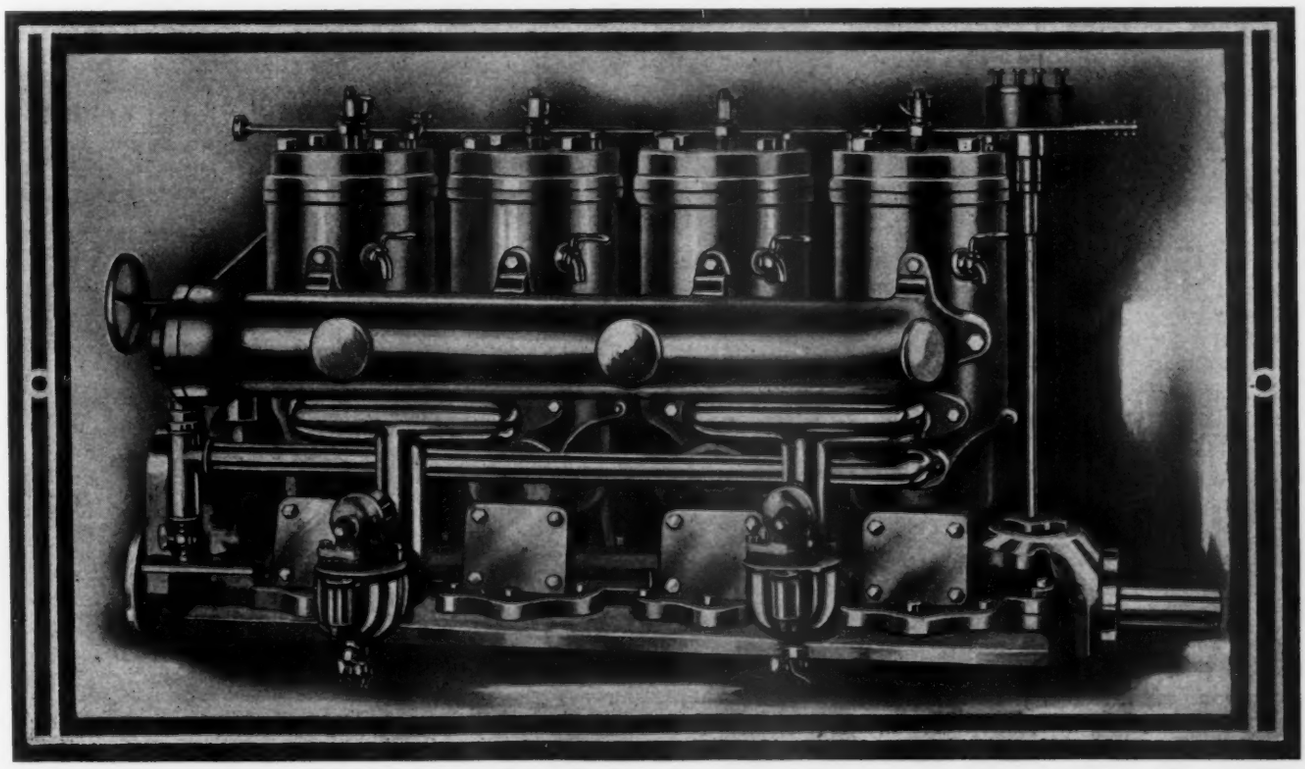


FIG. 1—AN ALUMINUM, TWO-CYCLE GAS ENGINE. ONLY THE CYLINDER LINERS AND THE FLY WHEEL ARE MADE OF CAST IRON

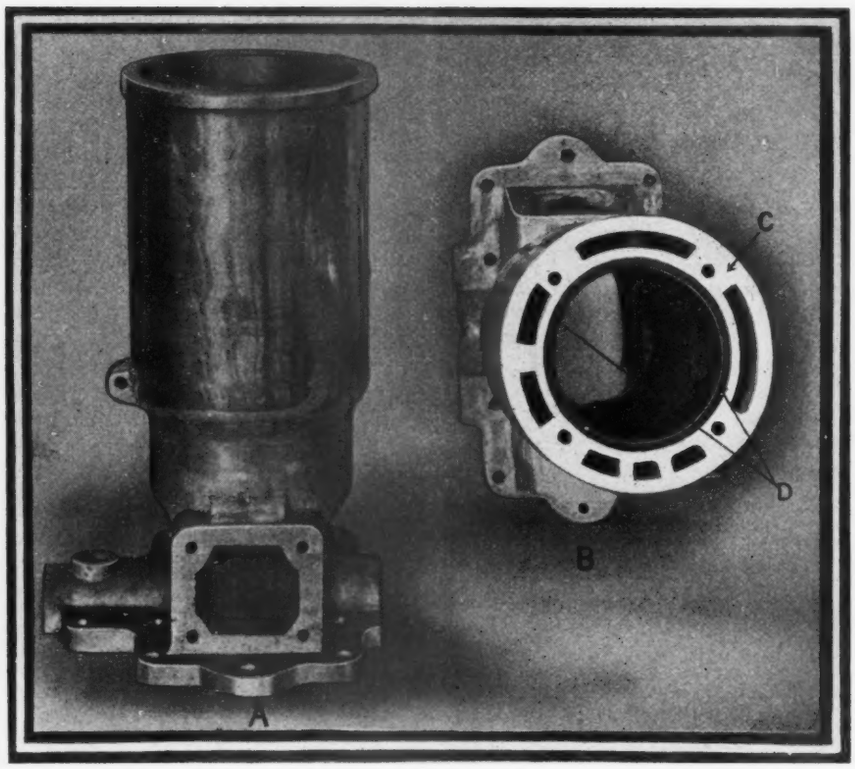


FIG. 2—AN ALUMINUM CYLINDER IS SHOWN AT *A*, AND *D* INDICATES THE GRAY IRON LINER

impossibilities of gas engine construction. It was his theory that the best method of joining a wear-resisting liner to the aluminum cylinder was to cast the aluminum onto the gray iron liner, and after many trials this has at last been successfully accomplished. It was found to be entirely a foundry problem, with the difference in the shrinkage of the two metals, the chief difficulty to be overcome. That the practice is not only occasionally crowned with success, is indicated by the recent production of 24 cylinders in one week without a single loss.

Aluminum Engine.

A four-cylinder, two-cycle gas engine, built entirely of aluminum, with the exception of the fly wheel and the cylinder liners, is shown in Fig. 1. This motor, not including the fly wheel, weighs 400 pounds, as against 710 pounds when made of gray iron, a reduction of 310 pounds in weight. The intake pipe of the cast iron engine is made of brass, and the exhaust pipe is gray iron, while in the lighter motor both are cast of aluminum. The aluminum cylinders have been subjected to every conceivable service test to ascertain whether a separation of the metals would be possible after continued operation. The engines have been run hot until nearly stalled, and ice water was then pumped into the water jacket, without effecting a separation of the aluminum and the iron. The engines have also been operated with the circulating water system cut off, and they have been jarred severely while running hot, without affecting the liners of the cylinders.

Equalizing the Shrinkage.

To equalize the shrinkage of the two metals as far as possible when casting, the liner is heated with a blow-torch immediately before it is set in the mold and just before the aluminum is cast. Furthermore, the aluminum is poured as cold as possible and yet at such a temperature to insure its running into all parts of the mold. It is claimed that these expansive iron liners, which absorb a large part of the heat of the explosions in the cylinders, correspond in exact co-efficience with the more expansive aluminum, which is heated by radiation from the liners, and is cooled by the water circulating in the water jacket.

The Cast Iron Liners.

Four of these cast iron liners are shown at *A*, *B*, *C*, and *D*, Fig. 3. They are made of a close-grained gray iron, approximately 3/16 inch in thickness, and are bored after the aluminum cylinder has been cast around them. It will be noted that the liners are scored, to further afford a seat for the aluminum. A liner in the reversed position to which it is placed in the cylinder, is shown at *C*, the gas intake ports are illustrated at *E*, and *F* indicates the exhaust ports. The opposite side of this liner is shown at *D*, *G* being the gas by-pass ports. The cast iron liner made in this way affords an opportunity to file the ports and to remove burrs and fins, which would otherwise stop the flow of gas through the gas passages. The smooth ports, it has been found, result in increased compression of fully 20 per cent, thereby resulting in increased power for a given amount of fuel.

Cores.

One of these liners, *B*, in position on the main cylinder core *A*, is shown in Fig. 9. To provide a core that

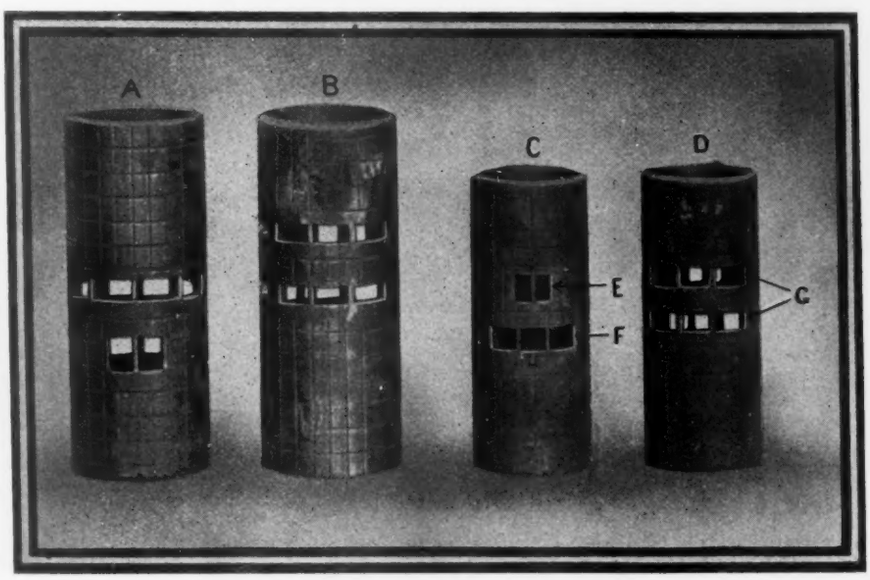


FIG. 3—GRAY IRON CYLINDER LINERS

will vent freely the mixture of this main cylinder core consists largely of sawdust with linseed oil as the binder. This core likewise cores out the base of the cylinder. The gas inlet core, *C*, is attached to the main cylinder core, *A*, after passing through and fitting snugly to the cast iron liner, *B*. The exhaust core is shown at *D*, and *E* is the by-pass core. These cores are all separately shown in Fig. 8, in which *A* is the body core, *B* the by-pass core, *C* the exhaust core, *D* the gas intake core, *E* the water outlet core, and *F* the step core.

In Fig. 4, *A* is the core box for the cylinder core, and *B* is the pattern of the cylinder. The main core prints are shown at *C*, the exhaust print at *D*, gas intake print at *E*, and the body print at *F*. The main cylinder core is shown at *D*, Fig. 5, and the sleeve, or liner core, which is a part of the main cylinder core, is illustrated at *C*. *A* and *B* are the water jacket cores, *A* being the cope core and *B* the drag half of the water jacket core.

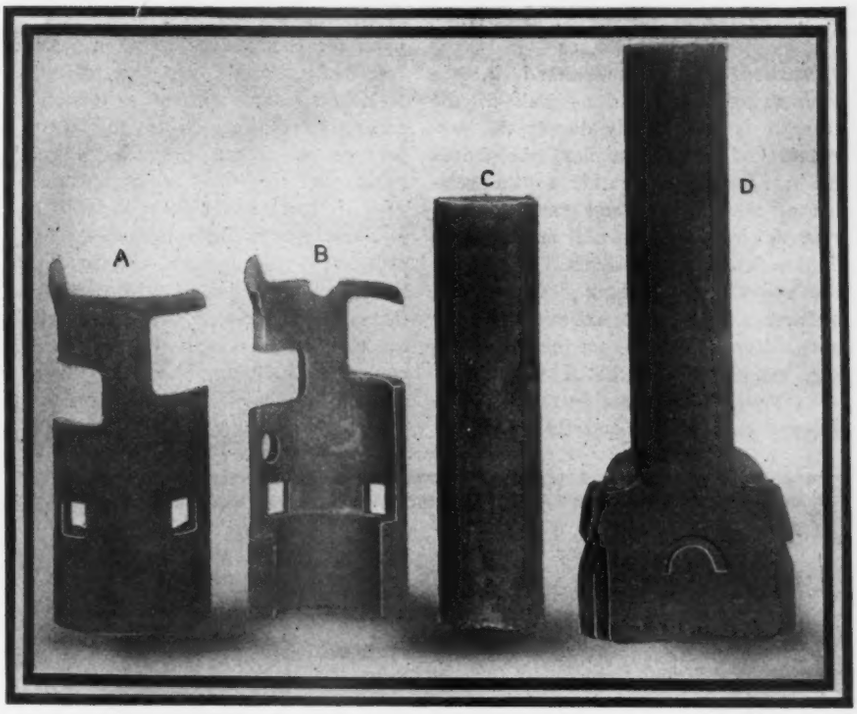


FIG. 5—WATER JACKET AND MAIN BODY CORES

The Mold.

The drag half of the mold with the main cylinder core, cast iron liner, exhaust, intake, and by-pass cores in position, is shown in Fig. 6. It will also be noted that the water jacket core, *A*, is in place and helps to hold the main cylinder core in position at the top of the mold. The space through which the aluminum flows to form the water jacket is shown at *B*, and the opening for the metal that is cast against the gray iron liner is indicated by *C*. The end of the water jacket is shown at *D* and this is the point where the aluminum again contacts with the cast iron liner. The drag half of the mold is again shown in Fig. 7 with the cope half of the water jacket core, *A*, in position, just before the mold is closed. The liner is heated with a blow-torch immediately before it is set in the mold, and the metal is cast as soon thereafter as possible. A standard aluminum alloy is used, furnished by the Aluminum Co. of America, Pittsburg, which contains aluminum, 92 per cent, copper 8 per cent and a small amount of nickel.

The cylinder is cast in a horizontal position, and a casting without the gates or risers removed, set on end, is shown in Fig. 10. This photograph was made within one minute after the casting was shaken out of the sand. The method of gating is clearly indicated, risers being provided at the base of the cylinder, with an overflow at the top of the cylinder, so as to insure the flow of the aluminum around the cast iron liner and to provide ample metal for shrinkage. In this illustration the exhaust core print is shown at *A*, the intake core print at *B*, the step core at *C*, the body core at *D*, and the main cylinder core at *E*.

One of these cylinders, after it has been polished is shown at *A*, Fig. 2, and *B* is a view of the top of a cylinder, which clearly shows the gray iron liner and the aluminum which is cast against it; the gray iron liner is shown at *D* and the aluminum at *C*. This cylinder weighs, finished, 37 pounds, as against 81 pounds when cast in gray iron.

All of the aluminum parts of the engine are highly polished, and in appearance it is more handsome than the motor provided with cast iron cylinders, regardless of the finish.

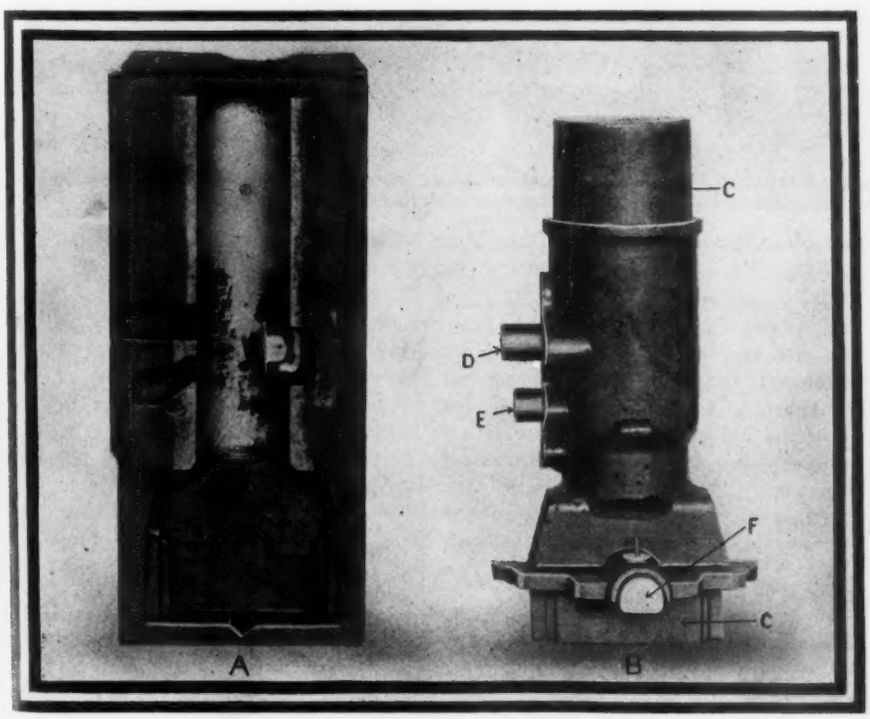


FIG. 4—THE CYLINDER CORE BOX AND PATTERN

HARDNESS OF CAST IRON.

By W. J. Keep

Question:—As I understand it, the hardness of cast iron, as well as the strength, is not directly due to the percentages of silicon, sulphur, phosphorus and manganese, but rather to the relation of the graphitic and combined carbons as obtained by the manipulation of the first four elements. If this is true and I have a casting of a certain hardness and strength, containing 2 per cent silicon and 0.45 per cent manganese, can I assume that I will obtain the same hardness and strength with 2.40 per cent silicon and 0.55 per cent manganese, the sulphur being 0.08 per cent and the phosphorus 0.65 per cent in each?

Furthermore, can I counteract the influence of an increase in silicon by an increase in manganese and maintain uniform hardness and strength, particularly the latter? Is one of these mixtures better than the other for withstanding continuous heat from a coal fire to which fire pot and cast iron sections for boilers are subjected? What is a good mixture for this class of work, where the thickness averages ⅜ inch, and the casting must not be porous?

Answer:—Strength of cast iron depends upon how the crystals are interlocked, as well as their size, more than upon the chemical composition. An element which produces a fine, closely interlocked grain, without brittleness, increases strength. Decreasing the percentage of silicon produces a smaller grain and increases combined carbon, and if carried far enough will cause brittleness as well as hardness. An increase of silicon in a casting ⅜ inch thick, which will reduce brittleness, will increase the strength. When practically all of the combined carbon has been converted into graphitic a further increase of silicon would increase the softness of the iron. Manganese does not necessarily increase combined carbon and an increase of silicon will not counteract the hardening influence of manganese. Up to 1 per cent, the hardening influence of manganese is not noticeable, but it is true that increasing manganese steadily will increase the hardness of the iron irrespective of any increase in the percentage of silicon. For this reason you cannot balance one of these elements with the other.

A coal fire influences cast iron most when the iron is red hot. The volume is increased, as, for instance, on the side of a fire pot, next to the fire. This causes the outside surface to crack, while the inside surface, having absorbed oxygen and sulphur, has very little strength and the seams soon result in cracks.

The increase in the length of these castings is frequently as high as ⅛ inch in 1 inch, this increase being permanent. An iron with a low percentage of silicon and high in combined carbon will "grow" more than a very soft iron, and for this reason the best iron for the purpose is one that is low in combined carbon, high in silicon, contains manganese approximately 0.50 per cent, and a high percentage of phosphorus, which should not be over 1 per cent. This also applies to grate bars. However, I wish to be understood that these expressions are not the result of experiments.

Hardness and toughness are not the same, although both oppose the tool. This condition, however, is generally styled hardness, although a better term would be "workability." Combined carbon undoubtedly produces hardness, but not toughness, while manganese certainly seems to harden iron and produces increased toughness. It is not at all certain that it adds to strength.

A cast iron is often pronounced hard by a grinder who cannot cut through the surface with an emery wheel, while a drill or other tool will cut it easily

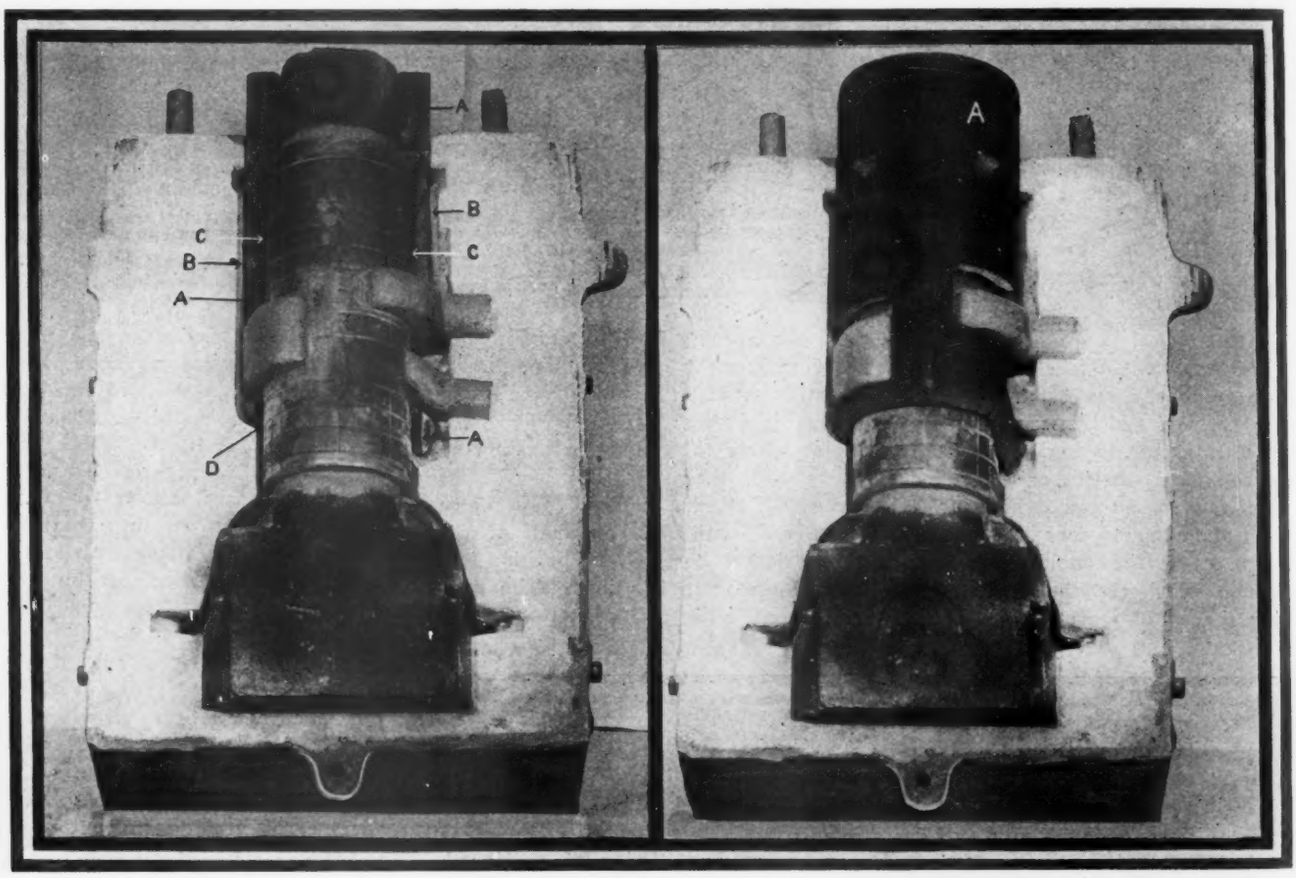


Fig. 6—Drag Half of Aluminum Cylinder Mold, Showing Gray Iron Liner on the Main Body Core

Fig. 7—Drag Half of Mold with Water Jacket Core in Position Just Before the Mold was Closed

"Workability" of a casting, which is the important shop condition, cannot always be traced to a certain chemical element, and yet a founder can improve the workability of a casting and increase the hardness by increasing the silicon, and by permitting the casting to remain in the sand over night. This can also be accomplished in some instances by pickling, and will always be brought about by annealing. A hardness testing machine, equipped with a drill, will at once determine the "workability" of castings.

DIFFICULTIES WITH MOTOR CAR CASTINGS.

Question:—We are experiencing considerable difficulty in making brass automobile castings, as they are full of blow-holes and show surface imperfections. They must take a very high polish, but the pin holes on the surface cannot be removed by the polishing operation. Our mixture consists of copper 60 and zinc 40. We use plenty of charcoal and melt with coke in pit furnaces. The brass is cast as dull as possible. After the pot has been lifted out we add about one ounce of aluminum and also use one pound of tin, which is added to the metal just before the pot is pulled. The zinc we use is remelted material and is made from sheet zinc, which is used in the manufacture of fruit jar lids. The shrinkage of the metal is also unusually high.

Answer:—Your mixture is too high in zinc to cast well in sand. An alloy of 70 per cent copper and 30 per cent zinc would be better, and this mixture can be cast without the addition of aluminum, which always makes it more difficult to obtain clean castings. A good yellow brass for automobile castings, and one that the writer has frequently used, follows: Copper, 72 per cent; zinc, 25 per cent; tin, 2 per cent; lead, 1 per cent. The tin is necessary to strengthen the metal and the lead improves the machining qualities and can be increased and decreased as desired. The first alloy mentioned—copper 70, zinc 30,—will of course, need stiffening with tin.

The alloy of 60 per cent copper and 40 per cent zinc is often called Muntz metal, and it is difficult to get clean castings in sand from this mixture. If you are obliged to use this, I would advise increasing the quantity of aluminum to 4 ounces, as this metal gives the alloy casting qualities. The castings will then have the well-known appearance of manganese bronze, in fact, many founders call this mixture manganese bronze. These high zinc alloys require careful melting to avoid the oxidation of the copper. This latter metal when melted should appear limpid underneath its covering of charcoal before the zinc is added. If there is any mush or thick metal on top of the copper, an attempt should be made to purify the alloy before the zinc is added. In this case probably the best thing to use would be manganese-copper. One-half pound should be added and the copper should be thoroughly stirred. More charcoal should be used and the metal should be reheated a few minutes, and if it does not clear, repeat the dose of manganese until the mush is reduced. The insides of old dry batteries, if you can procure them, notably those known by the trade name of Columbia, which contain oxide of manganese, will prove invaluable as a covering for high zinc alloys.

We do not believe the zinc is at fault, as oxide of zinc does not dissolve in the metal as copper oxide does in copper, and therefore, as long as the fruit jar lids, etc., are first run into ingots, the zinc, while not possibly of a high grade, will be suitable for your purpose. It might, of course, be high in lead, which would reduce the strength of your alloy, but as you do not claim to be making a manganese bronze this would be immaterial. The shrinkage of such alloys is always high and this must be overcome by suitable risers or feeders. If you experience trouble from dross when increasing the quantity of aluminum, you can substitute silicon to advantage. Use 1 per cent of silicon-copper, which will increase fluidity the same as aluminum, and will also deoxidize your metal. K. K.

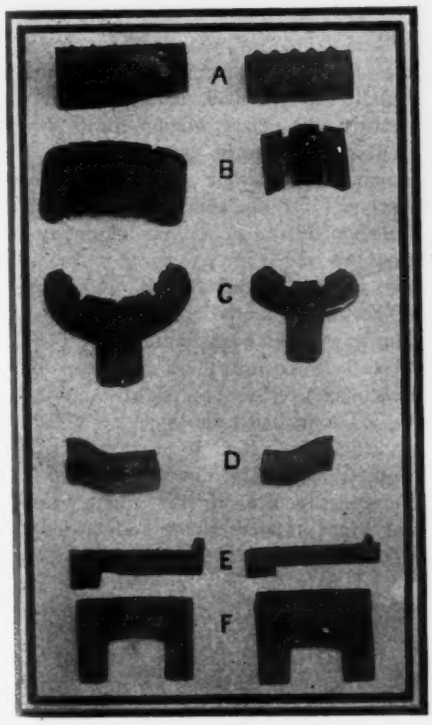


FIG. 8—MISCELLANEOUS CORES FOR CYLINDER MOLD

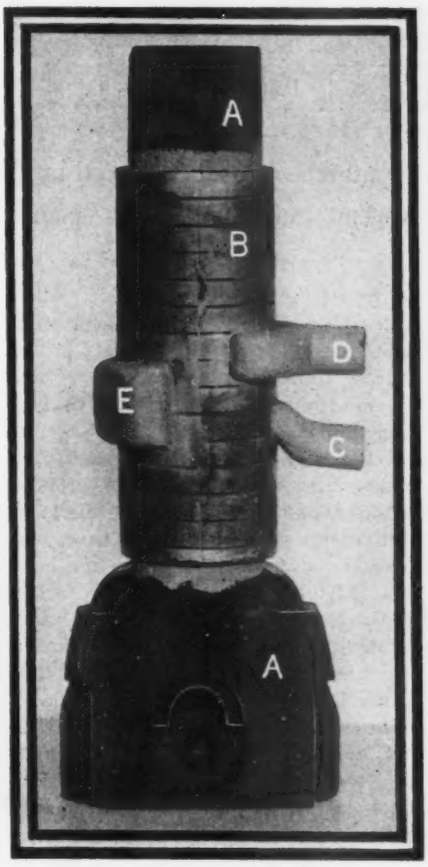


FIG. 9—CAST IRON LINER ON MAIN CYLINDER CORE, WITH THE PORT CORES IN POSITION

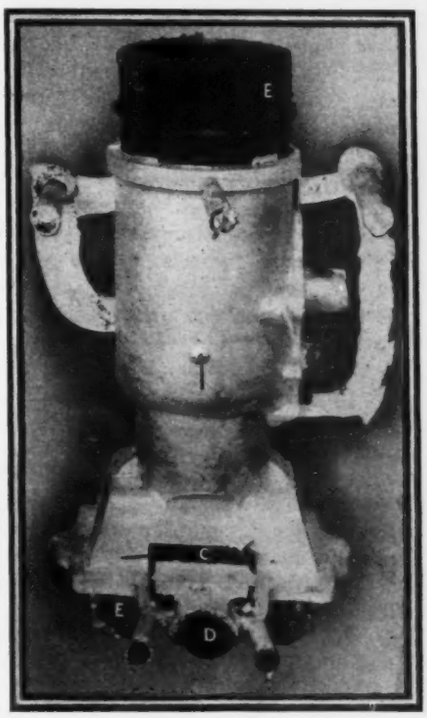


FIG. 10—THE ALUMINUM CYLINDER AS CAST, BEFORE THE CORES, GATES AND RISERS WERE REMOVED

FIRE PREVENTION IN FOUNDRIES*

How the cost of insurance may be reduced by the installation of sprinkler systems and by proper plant construction

BY SIDNEY G. WALKER

THE public, by experience, is best acquainted with insurance as handled by so-called "stock companies." These have been organized primarily for the purpose of paying dividends to stockholders, and in consequence are chiefly interested in collecting a premium, sufficient in amount, to show a balance of profit. While their work is of unquestionable value in distributing losses so as to soften the force of the blow to the individual sufferer, the most prominent feature seems to be that of a gamble with fire hazards, rather than a consistent or concerted attempt to eliminate losses and conserve property.

Mutual Insurance.

Though less widely disseminated, the mutual principle, when properly applied, is undoubtedly more advantageous from the standpoint of those most vitally interested—the property holders—and no discussion of this subject would be complete without considering the salient features of this system, especially as it has been elaborated by the so-called "New England Factory Mutual Fire Insurance Companies." The results which these companies have secured their members, during a long business experience, have represented the acme of insurance from the standpoint of the assured, and their present-day figures are absolutely the last word in low insurance cost in the particular field in which they operate.

They are essentially an association of manufacturers, who have joined forces for purposes of mutual advantage, and were originally organized because the individual members had been unable to secure from stock companies, concessions in rate to which they considered themselves entitled. They operate without profit or commission to anyone, furnishing their members insurance at the actual cost of production.

Their work is confined entirely to high grade manufacturing properties, and as they include a very large percentage of the most prominent combinations of industrial capital in the eastern United States, they are today pre-eminently the ruling factor in their field.

Early realizing that on a strictly mutual basis, conservation of property is the primary and vital consideration, their energies and resources have been concentrated to that end, with the highly gratifying result that typical factory properties have been shifted from among the most undesirable classes of insurance to a position very near the head of the list.

The foundry, with its affiliated industries, constitutes a very prominent branch of manufacturing and one intimately associated with the development of the mutual companies. It will therefore be logical in examining into the possibilities of reduction in cost of foundry insurance, to refer somewhat in detail to the methods employed by these companies.

Cost of Insurance.

The cost of insurance, in general, may be resolved for purposes of analysis into three chief factors—loss ratio, expense ratio and profits—and an examination into the possibilities of cost reduction in the abstract, or as applied to any specific class such as foundries, may well be undertaken by discussing the elements which go to make up these sub-divisions.

In the above sub-division of cost, the only feature upon which the property owner may be said to have a direct influence, is the loss ratio.

Dividends.

Whatever the system of insurance, the community as a whole pays for the losses in the long run, and the companies simply serve to distribute this tax with more or less uniformity. With the mutual companies, operating as they do, the result is directly and immediately dependent on the losses. Having no stockholders, their plan, in order to secure funds for comfortable operation, is to charge in advance a premium rate safely in excess of what will probably be used for fire losses and operating expenses, and at the end of the policy period, after deducting these items and crediting the interest income, the balance is returned to the assured in the form of a rebate or dividend.

Premiums of Stock Companies.

The stock companies' rates are originally placed high enough to cover losses in their probable ratio as determined by statistics covering a period of years, but when this assumed amount is found to be insufficient, as it may be through the fracture of averages by a succession of large losses, or the occurrence of a conflagration, a raise in rates commonly follows throughout other sections of the country than that directly affected, as witnessed by a general increase all over the country following prominent conflagrations which have occurred in the United States.

It is also true that a marked reduction in fire losses will generally bring about a lower cost of insurance, although this is more equitably and promptly true with the mutual companies, but public opinion and competition will force lower rates following any considerable and permanent reduction in fire loss.

Annual Fire Losses.

Statistics show that the annual structural fire loss in the United States will average about one-half of the new construction in that year. This property loss for several years past has been roundly $250,000,000 annually, not to mention the 1,500 human lives sacrificed; nor does the actual tax on the community stop there, for our carelessness calls for the maintenance of public fire departments at an annual outlay of about as much more, making the full levy nearer $500,000,000.

The mind cannot readily grasp the significance of these figures and it may be well to reduce them to more comprehensible terms. A short time ago, one of our scientific papers published an article in which it was stated that if the 165,000 buildings destroyed or damaged by fire in this country each year were ranged along both sides of an ordinary city street, allowing a frontage of only 65 feet on each side, the street would reach from New York to Chicago.

Average Loss.

This daily tax of roundly $1,500,000 means $60,000 hourly, or in figures which

*Presented at the March meeting of the Pittsburg Foundrymen's Association. Mr. Walker is fire protection engineer of the Manufacturers' Mutual Fire Insurance Co., Providence, R. I.

may be readily grasped, $1,000 a minute. Statistics covering 28 years, up to and including 1907, show an average loss of 61 cents per $100 insurance, or the equivalent of 56.5 per cent of a year's premium; nor has there been any material reduction in this average percentage during that period, in fact, the past decade has shown an increase of 1 per cent above the average, due, no doubt, to the San Francisco disaster.

Protective Measures.

Let us now examine the results of scientific study which the mutual companies have brought to bear on the reduction of fire loss. It is to be assumed, and figures bear out the assumption, that in the beginning their loss ratio was as great as, if not greater, than with the average risks throughout the country, but the direct effect on the pocketbook was so forcibly brought out as to draw their attention to the necessity for preventive and protective measures, and the result of concerted effort has been to bring the loss down to less than 2 cents per $100 a risk for last year, or about one-thirtieth of the average with the stock companies. Five years ago this ratio was 6 cents and ten years ago 7 cents, so it is apparent that the relief has been progressive and has resulted in the elimination of over 90 per cent of the losses on this class of property. Double the average loss with the stock companies and a year's premium is wiped out, while with the mutuals the cost of insurance would only be increased $20 per $100,000.

Fires Caused by Carelessness.

Many elements enter into the make-up of the loss ratio, and not the least prominent among these is that of management. We are told that 60 per cent of the fires are from preventable causes, or plainly speaking from carelessness.

The elimination of carelessness is largely a matter of education, and therefore of minute and frequent inspections by those competent to detect and remove conditions which make for fire loss. The mutual companies are preeminently in the lead in the excellence of this service to their members. A corps of 21 men, carefully chosen for their special qualifications, visit in succession, four times a year, the plants included in the system, applying their composite experience with fires, their origin and extinguishment, to each plant as an individual.

Tests of Protective Apparatus.

Once a year the actuating features of the protective apparatus are tested to the full effective capacity and comparison of these results with the theoretical as well as with actual tests previously made, point out not only the acute defects and weaknesses, but also such chronic faults as a too-marked general depreciation, the interested parties being thus periodically assured as to the state of efficiency of the apparatus.

The stock companies, in recent years, have caught the spirit of fire prevention and have inaugurated systems of inspection, but much has yet to be done in perfecting the efficiency of this work, particularly as regards risks ranging from the low grade to about the average in desirability.

Measured by fire losses per capita, the American people are about eight times as careless as the representative foreign countries, while the actual number of fires are 40 per 10,000 inhabitants, as against eight in European cities.

Defective Construction.

Of the physical characteristics affecting fire losses, great importance attaches to construction. Our structures range from the poorest types, so built as to insure rapid destruction, to those designed for resisting the attack of fire to the utmost, but unfortunately the average is on the wrong side.

The American people hold all records for poor building, and this not only has the effect of making the actual property loss per capita eight to ten times that of our foreign neighbors, but necessitates the maintenance of fire departments in about the same ratio.

It is evident from a contemplation of such figures, that the heavy losses which we sustain, are very largely unnecessary, and that such waste demands careful examination. Undoubtedly, in the past, a governing feature has been our more readily available, and consequently cheaper, lumber supply, but this is becoming less and less important with the elimination of our forests and the development of higher grade construction.

Mill Construction.

The application of thought and skill to this subject was naturally of selfish interest to the mutual companies, and led to the development of slow burning or mill construction, the highest type of structure yet designed involving the use of combustible materials and depending for its effectiveness on the massing of timber into large sections, eliminating corners to the greatest possible extent, thus presenting large smooth surfaces for fire attack, and facilitating extinguishment when once ignited. The relative resisting powers of this type, as compared with the common or joisted type, were well set forth by two fires which recently occurred within a few weeks of each other, in which the conditions as to protection were as nearly as possible identical. The joisted roof fell on the fire in 20 minutes, while the slow-burning type held its position for 2½ hours.

Material for the Walls.

In important buildings the walls should be entirely non-combustible, preferably of brick or concrete rather than stone, the latter being one of the poorest fire resisting materials as evidenced by the fact, that after the Boston fire, granite piers several feet in thickness, were removed with shovels.

Steel, wrought iron and cast iron are unreliable under the action of fire in the order named, and should not be employed in important structures unless thoroughly protected against the access of heat.

"Fire-proof" as a term applied to buildings is distinctly a misnomer and apt to be misleading, for no material can be employed which is not subject to deterioration under the action of heat, particularly of such degree as obtains in a large fire.

Reinforced Concrete.

Undoubtedly the most advanced type of fire-resisting construction is reinforced concrete, and if properly erected, will usually permit of the consumption of any reasonable amount of inflammable contents without serious injury to the building itself.

In any building of more than one story, openings through the floors should be strictly eliminated or provided with automatic devices for closing when a fire starts. Stairways and elevators may be taken care of by placing them in outside towers with fire doors at the openings into the main building, and modern electric transmission does away with belt openings through floors, which formerly were quite common and have frequently demonstrated their undesirability.

Horizontal Fire Cut-Off in Foundries.

Foundries are quite commonly one story in height, so that the horizontal cut-off or retardent is of especial importance, the areas usually being excessive and the material of the roof combustible, in a very dry state, and therefore readily inflammable. Where substantial brick fire walls dividing areas are impracticable, or inadvisable, it has been found of value to construct fire curtains of plaster and expanded metal, galvanized iron or other suitable fire-resisting material attached to the roof trusses, and extending from the roof surface down as low as operating conditions will permit. These act as dams to hold a fire where it may be readily handled instead of permitting its almost instant spread over the entire area.

Foundry Roof Construction.

The rapidity of spread of fire in foundry roofs is hardly appreciated by the inexperienced. The superintendent of a

foundry, which burned recently, tritely expressed the fact by stating that the roof burned like paper and the particular structure referred to was of heavy plank on steel trusses, presumably slow-burning. In another instance the men working in the foundry abandoned their clothing hanging on the posts, simply having time to escape.

As the contents of a foundry only involve a small percentage of combustible materials, unless patterns or wooden flasks are stored or allowed to accumulate, considerable favor has been shown to non-combustible roofs which may be of tile or some type of reinforced concrete, but even then the steel work should preferably be protected if combustible contents to any extent are involved.

The United States government has learned the importance of building well, and as a result now owns buildings which cost more than $300,000,000, upon which not one cent of insurance is carried against loss by fire. Insurance at the ordinary rates would cost about $500,000 a year and the government avoids this heavy tax by erecting its building in such a manner as to resist the attack of fire, which essentially makes it a system of mutual insurance.

A feature of fire risk, which particularly refers to the processes carried on and the inherent hazards, is that of occupancy. In the foundry class fortunately, these hazards are not serious or obscure. Careful insulation around stacks and cupolas to prevent ignition of wood-work and the elimination as far as possible of combustible flasks, patterns, etc., will reduce the probability of fire to a minimum. There have been instances of furnaces or core ovens exploding where heated by gas, but the methods of guarding against such accidents are perfectly obvious.

Protection Against Exposure Fires.

For immediate exposures, blank fire walls, shuttered openings, wire glass windows, and outside sprinklers are the best known means of protection, but these should be supplemented in instances of sufficient importance with powerful fire pumps. The value of the latter, in holding in check exposure fires, was handsomely demonstrated in the Paterson fire, where a line of mutual risks, with their fire pumps, confined the fire within its ultimate limits, and without suffering a dollar's loss themselves.

However thoroughly the careless causes of fire are weeded out, it will remain an axiom that fire will start and the last step in the reduction of fire loss is the provision of protective apparatus wherever combustibles are present in structure or contents.

Protection, that is, the installation of devices or apparatus for extinguishment of fires, may be either internal or external, as circumstances dictate.

It was early evident, in the operation of the mutual system, that it is good business to spend money for apparatus before a fire, rather than to pay for a plant after its destruction. The earliest form of fixed apparatus, after hose standpipes, was perforated pipe which consisted of light wrought iron, or even in some cases tin piping, with holes punched, with more or less symmetry, along the bottom and sides, attached to the ceiling and connected with a supply under pressure, so that by opening a valve the particular compartment controlled might be flooded. The incidental water damage was always tremendous, but much property was saved by this type of apparatus.

The next step was that of concentrating the orifices in the form of nozzles at certain points, with splash plates attached in such a manner as to insure good distribution, and supplied through a system of light piping. This had the effect of eliminating, to a considerable degree, the obstructing of the orifices and securing a more uniform discharge, since this type of device was capable of design along lines experimentally determined.

Automatic Sprinklers.

The great objection of extensive water damage still continued, however, and further study developed an automatic valve or plug, designed to retain the water under normal conditions, but by the fusing of low temperature solder to release it, when and where most needed, at the seat of the fire.

This was, in principle, the modern automatic sprinkler and was first introduced in an experiment in 1872. Many failures, both positive and negative, naturally developed as the scheme was exploited and the device perfected, but so rich was the evident reward in conservation of property, that failures were but made the basis of final success.

Today the typical manufacturing plant is completely sprinklered and the mutual companies have reached a point where they take on insurance only on those properties which are thoroughly protected, in which fact is largely the cause of the low loss raito they have shown in recent years.

No apparatus devised by man will put out a given fire with less water than an automatic sprinkler system after the point of efficiency of the fire pail is passed. They work most efficiently at the heart of the fire, amid smoke and flame where no fireman could live.

The standard factory equipment consists of complete sprinkler protection throughout the entire property, with two adequate independent supplies, one preferably of high pressure, and a fire pump where exposures are considered at all serious. A system of yard piping is necessary to distribute the supplies and provide suitable outside control for the various sections of the sprinkler system, which is usually furnished by post indicator valves located as far as possible from the building controlled, and sufficient yard hydrants, with equipment of hose and nozzles, are provided chiefly to take care of the exposure features.

External Fire Protection.

An effective means of preventing an outside fire from entering a building is an equipment of outside open cornice, or window sprinklers, operated by a valve conveniently located for access, backed up by a liberal water supply, the effect being to impose a water curtain preventing exposed inflammable parts, such as window frames, from igniting. Wire glass windows in metal frames, equipped with outside sprinklers, will undoubtedly hold in check most any fire which can be brought to bear on them. The chief defect in their operation is that they depend for starting on human agency, which has been demonstrated is chiefly reliable for its fallibility.

Damage Caused by Sprinklers.

Before experience had demonstrated the constructive reliability of the sprinkler system, some anxiety was felt as to the probability of water damage following the accidental opening of heads or bursting of pipes. The mutual companies gradually accumulated data covering the frequency and extent of such damage, and several years ago the evidence thus secured determined them to include this feature in their fire policies under the single premium. The comparative infrequency of such accidents is clearly illustrated by the fact that during last year, insuring about 2,500 distinct properties under the protection of approximately 6,000,000 heads, only 151 losses were reported; or in other words, one sprinkler in 40,000 caused damage sufficient for a claim in the mutual system.

Sprinklers in Foundries.

Before sprinklers were as common in foundries as at present, the question was raised as to the danger of life from the discharge of water into molten metal, and a series of experiments were conducted to demonstrate the result which would follow such conditions. First a sprinkler head was opened over a ladle of molten metal. This only resulted in rapid ebullition of water upon striking the iron and a free formation

of steam. Then pails full of water were dashed into a ladle with no more marked results, and finally molten iron was poured into a pot of water with no other than the anticipated effect of developing clouds of steam, which passed off harmlessly. There have been a number of instances of heads letting go over molten metal, due to the excess heat produced, but no more serious effect has followed than was developed during the above-mentioned experiments.

It is well known that the pouring of molten metal on damp or thoroughly soaked earth is hazardous on account of formation of steam in the crevices, which may be confined by the metal in such a manner as to produce explosions and throw the hot metal about in a dangerous manner, but this combination of conditions could hardly arise from the operation of a sprinkler system.

The cost of a protective equipment is governed by so many varying factors, that it can hardly be expressed in general terms, but the inside work commonly ranges from 3 cents to 6 cents per square foot of floor space covered, and an entire equipment, including outside piping and the necessary supplies, will range from 6 cents to 12 cents per square foot. This is an addition of about 10 per cent to the cost of the building and will serve to eliminate, roughly, 90 per cent of the fire losses.

A very gratifying feature, and one having a great influence on the present, quite general introduction of sprinklers into properties where conditions are suitable, is the fact, that the saving to be effected in the cost of insurance, is commonly sufficient to constitute a first class return on the outlay, viewed alone from the financial standpoint.

Instances are frequently noted where owners can secure a larger percentage of return on the investment by installing sprinklers than they secure from their manufacturing operations. Fifteen and 20 per cent are quite common, 30 per cent not unusual, while 50 per cent would not be considered remarkable.

As previously pointed out, no act of the assured will have a direct effect on the expense ratio. This portion of the cost of insurance is made up of salaries of officials, commissions of agents, office expenses, rents, taxes and inspection expenses, and while giving probably more effective services, the mutual companies have been able to effect a very material reduction in this part of the cost, as is well brought out by a comparison of an expense ratio of 5 per cent to 6 per cent of their annual premium with 40 per cent in the stock companies.

The third item, which goes to make up the cost of insurance to the assured, is that of profits, and its influence is naturally variable, but in the long run, must average pretty nearly uniform in order that dividends will be forthcoming to the stockholders. With the mutual companies, operating as they do on a cost basis, this factor is, of course, entirely eliminated.

Molding a Large Band Wheel

BY HERBERT C. SMITH

AMONG the principal difficulties which are encountered in molding and casting large band wheels, splitting the casting and forming the outside ring of the mold usually present the features of greatest interest. If care is not taken to allow for the split when making the mold, slightly elliptical wheels may result. Also, when the outside of the mold is made by ramming green sand against a segment pattern, difficulty is experienced in drawing the deep, thin pattern unless some method for keeping it clear of the walls of the mold in drawing is adopted.

Both of these problems—splitting the casting and forming the outside of the mold—were solved recently in an original manner at the plant of the Union Iron Works, Spokane, Wash., in casting a 12-foot band wheel.

The dimensions of the wheel were as follows: Outside diameter, 12 feet; width of rim or face, 38 inches; thickness of rim, 3 inches; depth of return flanges, which were cast on both sides of the rim, 2½ inches. There was a heavy central rib around the inside of the rim.

The wheel was molded in a pit, following the usual practice, the mold for the arms and hubs being formed of baked sand cores in the usual manner, while the inside wall of the rim mold was swept out with a one-sixth segment formed to sweep out the central rib on the inside of the rim.

Rim Splits.

The rim splits consisted of two pieces of ¼-inch steel riveted together on both ends and on the back as shown in Fig. 1. A thin sheet of asbestos was inserted between the sheets of steel. The rivets were all in the print left in the mold for the split. When the casting was cleaned, the ends and sides of the projecting steel sheets were cut flush with the rim split-lug and the sheets were left in the wheel as part of the casting in order to form a good bearing joint at the split without machining. Customary practice is to paint or oil the steel sheets so they will separate from the casting on cooling. No difficulty was experienced from the action of the slightly different co-efficients of expansion of the two metals in cooling and the steel plates were firmly fused integral with the cast iron rim. On account of the relatively greater contraction in cooling due to the larger bulk of metal at the hub, steel splits could not be used at this point and ordinary core splits were used instead. The casting was split by a machinist and helper in 35 minutes.

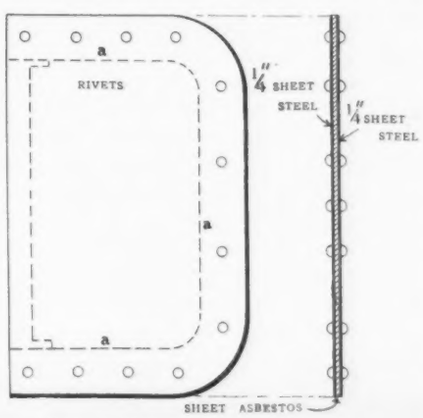


FIG. 1—SHEET STEEL RIM SPLIT

Having the pit dug, the bottom of the rim and prints for the inside cores were swept out by means of a spindle and step plate, also the foundation for the hub core was swept out. The sweep was then removed and the lower halves of the center cores were set in position, the exact position being determined by a point centered from the spindle. After placing the hub core, the arm cores were set in place and the remaining halves of the center cores were set. The arm and center cores were given a clearance of ½

inch to avoid filing the cores. Six clamps were used on each set of arm cores.

The outside wall of the rim mold, that is the outside ring, was made by ramming green sand against a pattern made to correspond to a one-sixth segment of the rim. Inasmuch as the rim was 38 inches deep and only 3 inches thick, it would be very difficult to draw the segment from the mold unless some expedient was adapted, and the following method was used: The pattern was made only 1½ inches thick, half the width of the mold. Eight wedges, each 38 inches long, 1½ inches thick at the large end and tapering down to a feather edge at the other were made. These wedges with their large and small ends together, forming four strips each 1½ inches thick, were placed behind the segment, as shown in Fig. 2, thus giving the necessary 3-inch thickness to the mold. After the sand had been rammed against the segment, the wedges were withdrawn and the pattern was thus left with sufficient clearance so that it could be easily withdrawn from the mold without tearing the sand.

The mold was closed on top with slab cores, 18 inches long and 18 inches wide. The whole upper surface of the mold was covered with a large cast iron plate bound down with pit binders.

The runner was made straight across the mold to allow pouring at two places, one-half of the runner being made in dry sand.

Pouring the Casting.

To pour the casting, a reservoir was made, 56 inches in diameter and 60 inches high, provided with two tap-holes on opposite sides, one a little higher than the other, the tap-holes being fitted with cast iron spouts. The reservoir was bricked up and secured the same as a furnace, and was placed on a sand bed at a height convenient to the dry sand runner.

To tap the reservoir, a plug was cast 6 inches long, 7 inches in diameter at one end and 5 inches at the other, with a 1-inch rod 6 feet long cast in the plug. When the tap-hole was built it was made around the plug, which came flush with the inside of the reservoir lining.

The reservoir was filled, using a 3,000-pound ladle to tap into form the cupola. A 1,600-pound ladle was placed under one tap-hole, which was to be tapped to drain any surplus iron from the reservoir. The other tap-hole was connected to the runner leading into the mold and a 4-ton ladle was placed so that it also fed into the runner. This 4-ton ladle was to be used in case the 6-inch opening in the reservoir would not keep the runner full, there being four 2½-inch diameter gates leading from the runner to the casting.

With all the iron in place the plug was drawn from the reservoir with ease and, as at first the stream would not fill the runner, the 4-ton ladle was brought into action. The hub was fed through two risers and the rim through four. Immediately after the cast the hub was uncovered. Four hours after the cast, the center core and hub split core were removed and after 48 hours the wheel was taken from the pit. The fly wheel was molded and cast by four men in 108 hours. Two men were molders and two were helpers. In other words, 216 molders' hours and 216 helpers' hours were required to finish the job.

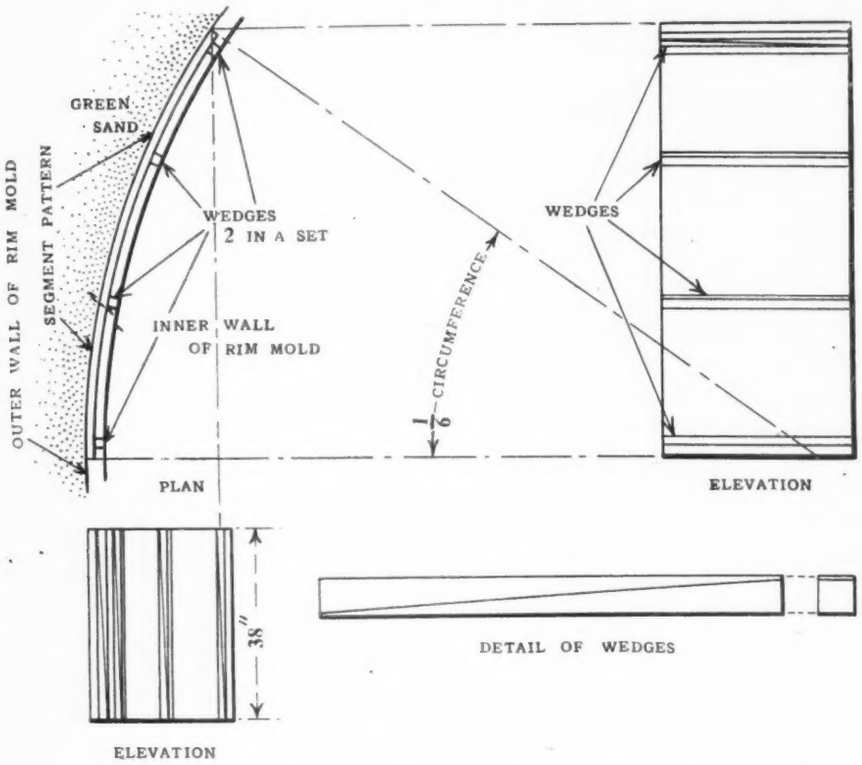


FIG. 2—ONE-SIXTH SEGMENT PATTERN, BACKED BY WEDGES USED IN MOLDING THE RIMS

FAST OR SLOW MELTING.

By W. J. KEEP

Cupolas of large diameters can be operated with higher blast pressures than those of smaller capacity, and the fuel economy will be greater. A cupola, 60 inches in diameter inside the lining, can be operated on an 18-ounce pressure. However, there is a loss in the melting speed when the pressure is increased above 22 ounces. To insure fast melting, the slag must be drawn off so that the iron will never be chilled at the tuyeres. In addition, the limestone must contain 80 or more per cent of lime. If it is a dolomite, with only 50 per cent of lime, you cannot prevent the tuyeres from clogging, and it will take more fuel to melt the iron. Furthermore, you will have a thick slag, as against a thin slag when good limestone is used. Oyster shells are recommended. The smaller the cupola the more fluid the slag should be. This also applies to low blast pressures, as it is easier to chill the slag in a small cupola. It is also necessary to use more fuel in a small cupola in proportion to the iron melted, and therefore the melting will be slower. About 20 pounds of good limestone per ton of iron charged will give a fluid slag. The amount of limestone can be increased if necessary, 40 pounds not being excessive, but every additional pound requires extra fuel.

A blast pressure of 14 ounces is a good average, and in large cupolas it will not chill the slag. A good fan will give a 14-ounce blast, and to obtain this pressure at the tuyeres, the pipes must be large and the elbows should have a large radius. A water column will rise 1½ inches for each ounce pressure, and therefore to record 14 ounces, the difference in height of the opposite columns would show 21 inches on the glass. A 6-ounce pressure will show 9 inches on the glass.

ENAMELED CAST IRON SANITARY WARE-XI

The manufacture of the enamel and slush including the grinding and melting, with a description of the furnaces

BY DILLEN UNDERHILL

THE department where the enamel is ground is known as the mill room, which is so termed owing to the resemblance of many of the machines therein to the tumbling mills in foundry cleaning departments. In the process of manufacture, the material is reduced to a powder, or pulverized in a manner similar to that of the conversion of wheat into flour. The building for this department should be three stories high, the upper or third story being used entirely for the storage of the raw material, which is received in bags. The bins into which the raw material is emptied are located on the second floor, the material being emptied into these bins through small trap doors in the floor. These bins are built of wood and are open along a common side to facilitate the filling of a steel tank or wooden box, which rests on scales and is moved along the floor to receive the proper quantities of the various ingredients from the bins, for the slush and enamel mixtures. In some mill rooms the bins occupy the greater portion of the second floor area, considerable space being used for the storage of these tanks or boxes containing mixtures prepared for the melting furnace.

Mills for Grinding the Enamel.

The mills for grinding the slush and the enamel are generally located on the ground floor, although in some cases these machines are on the second floor, where the ingredients are mixed. The melting furnace is always located on the ground floor and occasionally it is installed in a separate building. A sectional elevation of the mill department is shown in Fig. 1. The top floor is used for storage purposes, and as the material is received in bags and barrels, it is advisable not to divide this space into compartments. Some of the ingredients are purchased in carload lots, and as a result there is frequently an excess of one material, which, therefore, would interfere with the compartment arrangement. The floor should be well supported, as a load of 500 pounds to the square foot is not unusual. At the left is shown an elevator for conveying material to the storage floor. A side track should extend along the side of this building to facilitate the unloading of material from the car onto the elevator. The elevator, while shown at the end of the building, should be installed at one side, so that it can also be used for conveying materials to the second floor. The openings into the bins from the third floor are covered with trap doors to prevent foreign particles from falling into the various ingredients. The doors extend in a straight line across the building and are directly over the center of each bin. It is advisable to build these bins of wood and two sides should be held together with 4 x 6-inch lumber, while tie rods should be run through

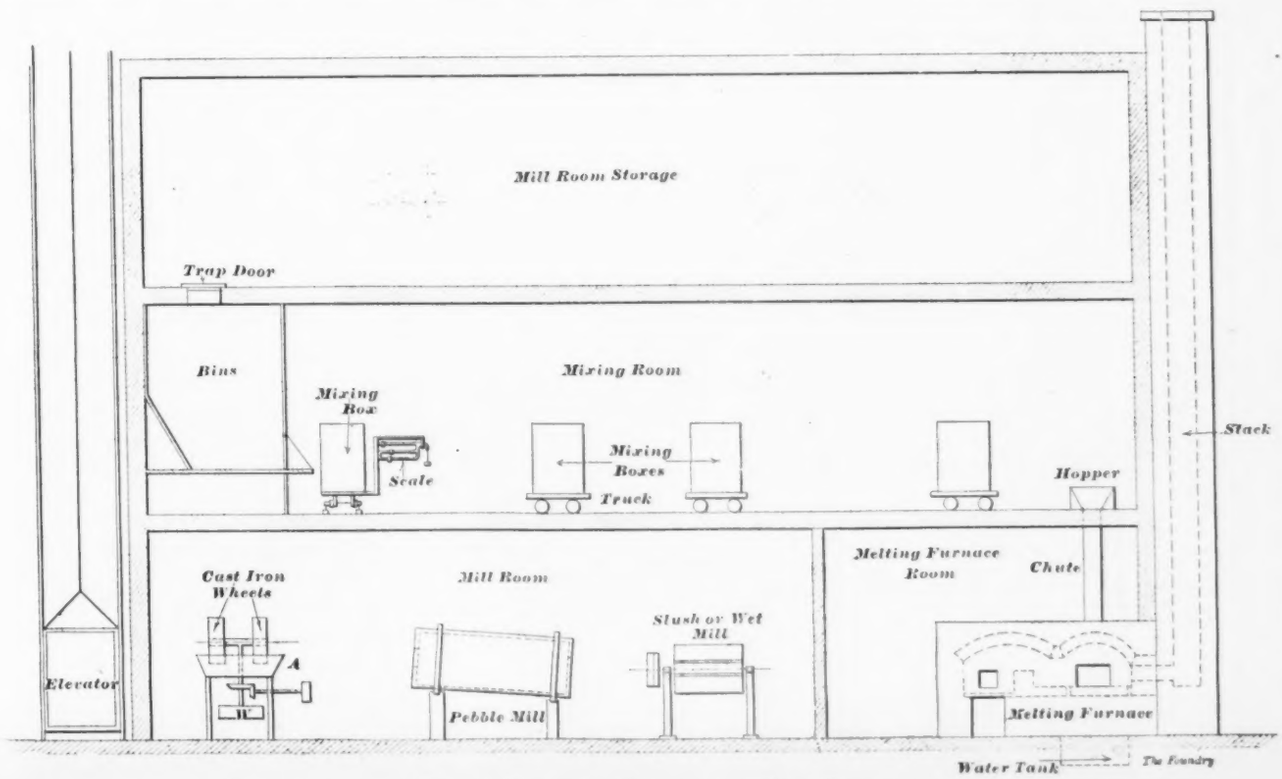


FIG. 1—SECTIONAL VIEW OF THE MILL ROOM

the ends to draw the sides together as the lumber dries. The bins should be hoppered at the back so as to cause the material to flow to the front, which facilitates the shoveling of materials from the bins into the wooden boxes.

Arrangement of Bins.

Some discretion should be exercised in designating the bins for the various materials, those similar in color being separated to minimize the dumping of materials into the wrong bin. If two white ingredients are placed in adjoining bins it is an easy matter to mix them accidentally. When making the mixture, the box should be moved from bin to bin in one direction across the floor, which greatly reduces handling, and the bins, when installed, should be arranged with this in view.

Mixing Box.

In Fig. 1 the mixing box is shown mounted on a platform scale, and if the enameling plant is small, this scale can easily be moved about by hand. However, if a large amount of material is to be handled, an industrial track system should be installed. Geared trucks can be used, built as low as possible, with a motor mounted at one end. The scale can be built into this truck or can be placed on top of the same, and on this the mixing box is set. A trolley wire is placed overhead, and by this arrangement the boxes can be speedily moved about from bin to bin to receive the various materials required. Recording scales can be used to advantage to obviate errors in weighing the various materials.

Delivery of Mixtures to Furnace.

In some plants the various ingredients are thoroughly mixed in these boxes, while in others it is the practice to mix these ingredients in a melting furnace. After the mixing boxes have been filled, they are transferred to low, four-wheeled trucks. Two of these wheels are so mounted that they can only move the truck forward or backward, while the other two wheels are free to turn around like casters. In some plants, the mixture is lowered to the ground floor, and is shoveled from these boxes into the melting furnace. This is a wasteful and slow method of handling the material. The arrangement shown in Fig. 1, with the melting furnace at one end of the building, on the ground floor, facilitates the transfer of the mixtures to the furnace. A chute extends from a hopper on the second floor to the furnace, and the hopper can be built of sufficient size to hold one charge, or at least as much of the mixture as is contained in one of the wooden mixing boxes. This hopper should be provided with a cover, and a sliding gate should be placed in the chute directly underneath the hopper. This gate will cut off the heat when it rises in the chute after the charge has been dropped. A bell hopper, similar to those used on blast furnaces might be used to advantage. The opening in the furnace through which the mixture is dumped is shown in Fig. 2.

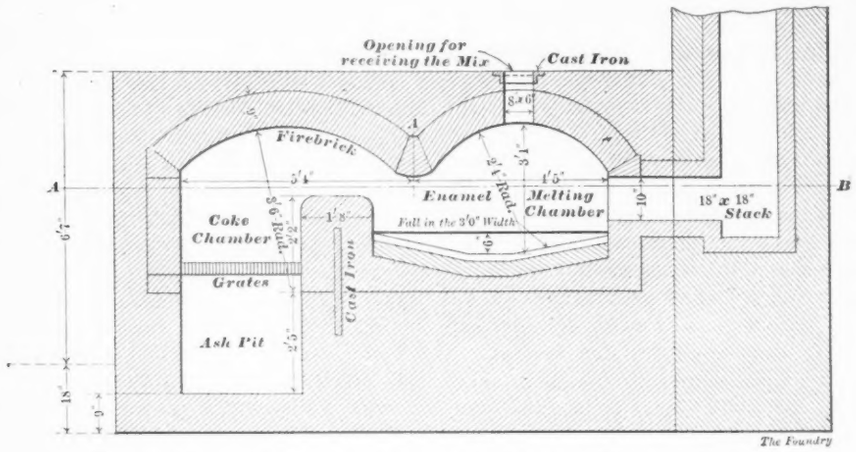


FIG. 2—LONGITUDINAL SECTION OF AN ENAMEL MELTING FURNACE

The Enamel Melting Furnace.

Either natural gas, oil or coke furnaces are used for melting the enamel. The nature of the fuel depends largely on the location of the concern. Gas is desirable as fuel if a constant flow can be assured. If, however, there is a shortage of supply, especially in winter, the furnaces will soon fall to pieces if they are permitted to cool too often. The use of gas, however, permits of the regulation of the temperature of the furnace more easily than any other fuel, and the melt can be carried on at a uniform rate. Oil also has many advantages as fuel, but is destructive to the furnace lining. Coke-fired melting furnaces are not easily controlled, and in the order of their desirability the gas furnace takes front rank, the oil furnace is second and the coke furnace last.

Longitudinal section and plan view of an enamel furnace are shown in Figs. 2 and 3. The furnace is of the reverberatory type, the roof and the sides being so designed as to cause the flame to impinge on the enameling mixture. To support the two arches over the melting chamber at *A*, Fig. 2, the fire bricks are keyed and by this construction the flame is forced down onto the bath of enamel. The arches spring from each end of the furnace, while the end walls are prevented from spreading by buck stays on the outside of the furnace walls, similar to those placed around brick settings for boilers. The lining of these furnaces requires constant repairs and for this reason

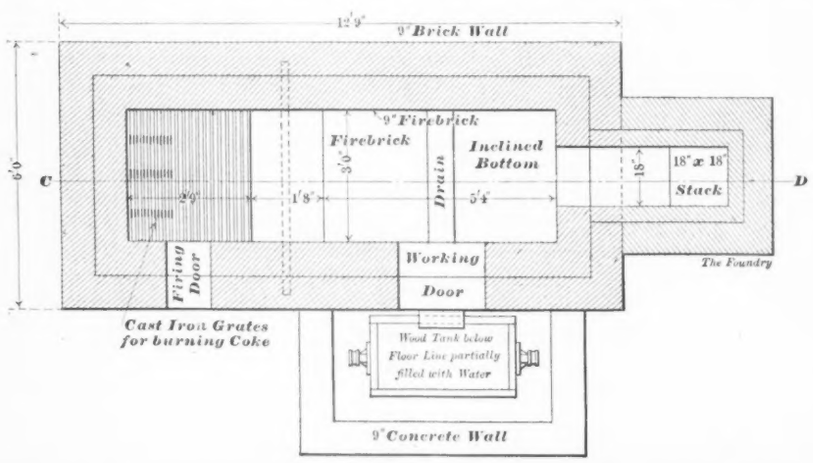


FIG. 3—PLAN VIEW OF ENAMEL MELTING FURNACE SHOWN IN FIG. 2

the fire brick should not be built into the common brick, of which the exterior of the furnace is constructed. In Fig. 2 the bottom of the enamel melting chamber is inclined toward the working door. The incline is about 6 inches in the total width of 3 feet. This slope in the bottom should be sufficient to permit the enamel to flow out readily into the wooden tank, filled with water, shown in front of the working door in Fig. 3, when the top spout is open.

Melting the Enamel.

The enamel, after being placed in the melting chamber, is leveled with a scraper or long iron hoe. The mixture must be constantly stirred, so as to insure a uniform amalgamation of all the ingredients. The furnace, when the mixture is charged, is still at a red heat after the previous mixture has been tapped out. In a very short time the mixture will begin to boil, as a result of the water in the borax being expelled in the form of steam, and also from the other gases which are set free by the heat. When the mixture has stopped boiling, the enamel is tapped into a tank filled with water, where it crystallizes in small particles, similar to granular slag made at blast furnaces, and which is used for track ballast, pavements, etc. The actions of the operator stirring this mixture are similar to those of the puddler making wrought iron. When using coke the fuel should be kept at a white heat, so as to complete combustion before the gases pass out of the stack, otherwise the carbon in the coke may absorb some of the oxygen of the various oxides in the "mix" and reduce them to their metallic state. This is not an infrequent occurrence when the furnace is not properly handled, and the enamel will contain black particles for which the mixer is at a loss to account.

In the sectional elevation of the furnace, Fig. 2, a cast iron bar is shown in the center of the bridge wall, which is inserted as a support for the fire brick. The grates are variously constructed, but wrought iron bars give excellent satisfaction and these are merely given a quarter turn when shaking down the coke. Cast iron grates are also used and a slice bar is employed to clean the fire.

Another Type of Melting Furnace.

The general dimensions of this furnace are given in Figs. 2 and 3. These will naturally vary with the amount of enamel required daily, and with the experience of each concern. Another type of furnace is shown in Figs. 4, 5 and 6. This is easier to construct than the melting furnace illustrated in Figs. 2 and 3, inasmuch as the arches extend across the furnace sideways. It will be noted that the top slopes toward the stack, thereby forcing the flame against the bath of enamel. In this type of furnace the floor of the melting chamber is level, the designer evidently not attaching much value to the drainage feature. As some of the enamel remains in the furnace after the bulk of the charge is tapped, this must be removed with a hoe. The author, however, prefers an inclined bottom melting chamber. It will also be noted that the melting chamber is wider than that shown in Figs. 2 and 3. The stacks of both furnaces are lined with fire brick to the top, and a cast iron water tank is shown in Fig. 5, into which the enamel is tapped. The wooden tank in Fig. 3 is lifted out of the pit by pneumatic cranes, and the excess water is poured off before the enamel is removed. The coke furnaces of the two types are similar, and the method of supporting the grate is shown in Fig. 4. The furnace, Fig. 5, is fired from the end, but this can be arranged as desired, according to the location of the furnace in the building. An end elevation of the furnace shown in Fig. 5, is illustrated in Fig. 6. The brick work is held together with cast iron stays, and the arch over the melting chamber is indicated by dotted lines. The ash pit and firing door are also shown. The main door, which is not illustrated, is hinged at the side, as are also the ash pit and firing doors.

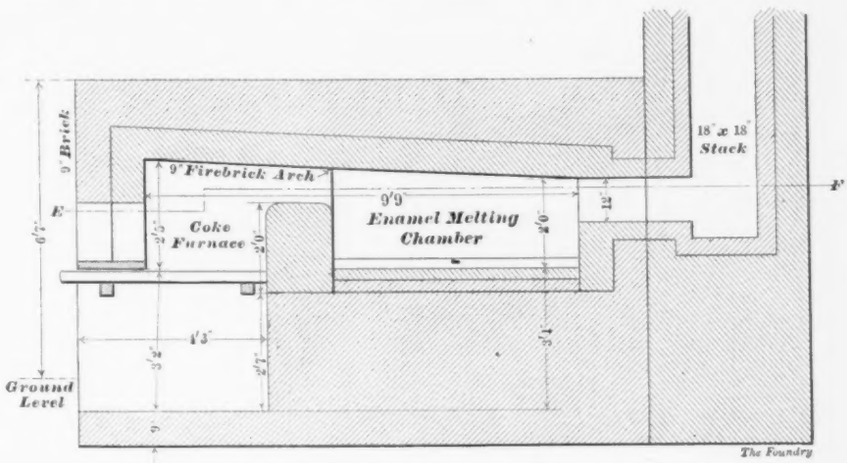


FIG. 4—LONGITUDINAL SECTION OF MELTING FURNACE ON LINE *GH*, FIG. 5

Gas as Fuel.

When gas is used for melting the enamel, complete combustion takes place over the molten bath. Care must be exercised to regulate the size of the air opening to the quantity of gas admitted. The gas enters the furnace through several openings and

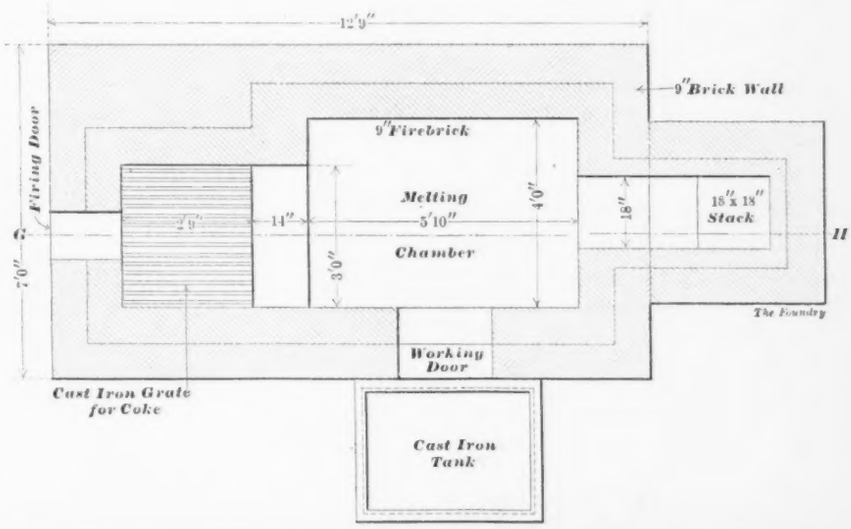


FIG. 5—PLAN VIEW OF THE ENAMEL MELTING FURNACE SHOWN IN FIG. 4

natural draft will provide the proper amount of air required if the brickwork is cut away sufficiently. A ratio of 1 gas to about 7 of air will give good results, but this will have to be varied somewhat, owing to the difference in the heat units contained in natural gas in various localities.

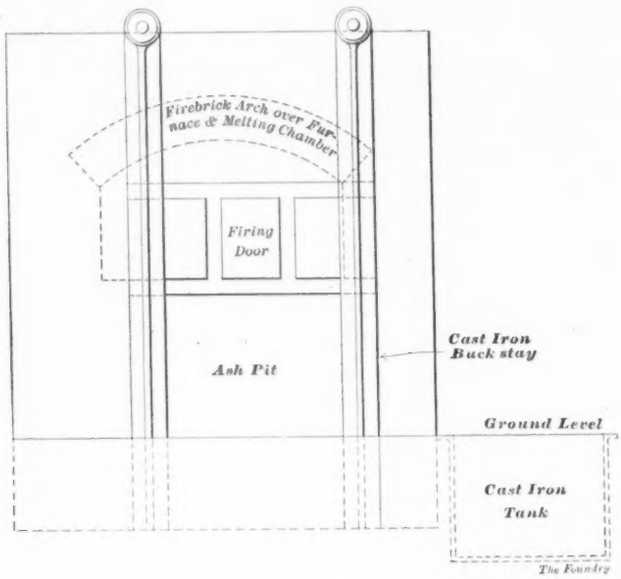


FIG. 6—END ELEVATION OF MELTING FURNACE SHOWN IN FIGS. 4 AND 5

Oil Furnaces.

Oil furnaces are equipped with only one burner and the oil is forced out at a low pressure. A suction pipe is attached, from which the compressed air is discharged and atomizes the oil. Oil, however, has a tendency to burn out the furnace lining, and in addition it is difficult to always obtain the same grade of fuel oil. As a result, continual trouble is experienced with the burner. If the oil is of poor quality, the paraffine which it contains soon fills the pipes, and it may be necessary to take apart the system if steam cannot be forced through the pipes to melt the paraffine.

Preparing the Enamel for the Furnace.

After the enamel has been crystallized the adhering water must be removed before grinding. This is accomplished in several ways. Some concerns place pans containing the crystallized enamel on top of the melting furnace and dry the enamel in this way, while others place the enamel in an inclined revolving cylinder, which is heated. Others build a special oven or furnace, shown in Fig. 7. The enamel is placed in a large cast iron pan and as it dries it is removed to the small or second pan, from which, after being dried, it is conveyed to the grinding department. These pans are easily made, being cast bottom up in open sand, the bottom being made sufficiently thick to prevent distortion when heated. The entire bottom surface of the pan is lined with fire brick, and a center fire chamber wall extends underneath the long pan. The furnace is provided with a cast iron grate, and coal or any other kind of fuel can be used. This furnace can also be built for the use of waste heat, which enters through the ash pit, and coal or coke is only used in case of an emergency. This furnace should be located near the melting furnace in the mill room, and if the melting furnace is not too large, the drying pans can be cared for by the furnace operator.

Grinding the Enamel.

After the water has been removed from the crystallized enamel, it is ready for grinding. Two types of machines or mills are used for this work. Originally the mill shown at *A*, Fig. 1, was employed extensively. It is equipped with two large cast iron wheels, 24 inches in diameter and 8 or 10-inch face, mounted on a single shaft. These rotated about a pivot in the pan and rolled over the enamel, crushing it to a powder. Scrapers were used, which stirred up the enamel after each wheel passed over the crystals. A bevel-gear drive was employed, the machine being belt-driven. To increase the crushing power of the wheels, weights were added to one end of the pivot shaft at *W*. A similar type of mill is used for mixing and crushing sand, but the objection to this for reducing the crystallized enamel to powder form, is that great care must be exercised by the operator to prevent the enamel from being ground too fine. Pebble mills are a recent innovation and consist of a steel cylinder lined with flint brick, in which round flint stones or pebbles are placed, together with the crystallized enamel. The action of this machine is similar to that of the tumbling mill, in that the particles rubbing against each other, as well as the sides of the mill, reduce the enamel to a powder. These mills are usually inclined, the powder flowing out at one end by gravity.

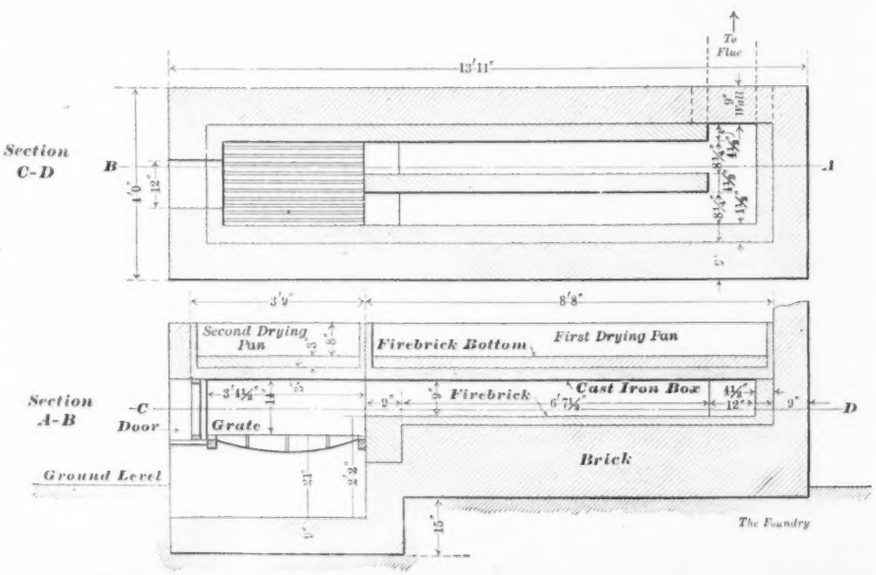


FIG. 7—PLAN VIEW AND LONGITUDINAL SECTION OF FURNACE FOR DRYING ENAMEL

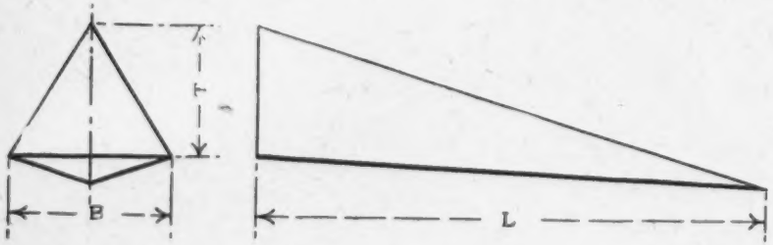
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication.

FORMULAS FOR FINDING THE WEIGHTS OF IRON CASTINGS.

By W. L. Tryon.

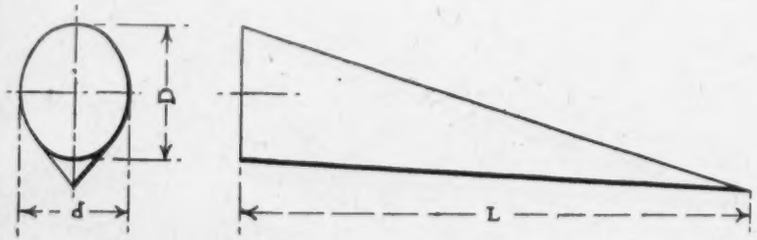
To find the weight of a triangular pyramid, multiply the width of the base by its thickness, by the length, by 0.0434.

$$W = BTL \times 0.0434.$$



To find the weight of an elliptical cone, multiply the large diameter of the base by the small diameter, by the length, by 0.0682.

$$W = DdL \times 0.0682.$$



W = Weight of casting in pounds.
B = Width of base in inches.
T = Thickness of base in inches.
L = Length in inches.
D = Large diameter of base in inches.
d = Small diameter of base in inches.

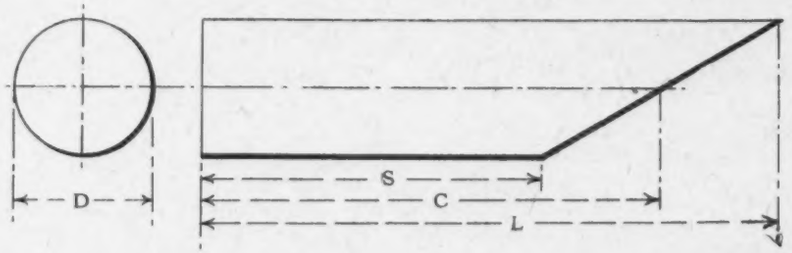
Data Sheet No. 63, The Foundry, April, 1910.

FORMULAS FOR FINDING THE WEIGHTS OF IRON CASTINGS.

By W. L. Tryon.

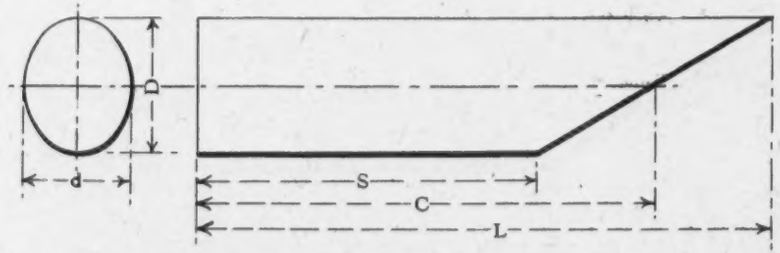
To find the weight of a truncated circular cylinder, multiply the diameter squared, by the distance on the center line from the base to the inclined section, by 0.204, or multiply the diameter squared, by the sum of the longest and the shortest distances from the base to the inclined section, by 0.102.

$$W = D^2C \times 0.204 \text{ or } W = D^2 (L + S) \times 0.102.$$



To find the weight of a truncated elliptical cylinder, multiply the large diameter by the small diameter, by the distance on the center line from the base to the inclined section, by 0.204, or multiply the large diameter by the small diameter, by the sum of the longest and shortest distances from the base to the inclined section, by 0.102.

$$W = DdC \times 0.204 \text{ or } W = Dd (L + S) \times 0.102.$$



W = Weight of casting in pounds.
D = Diameter of circular base or large diameter of elliptical base in inches.
d = Small diameter of elliptical base in inches.
C = Distance on center line from the base to the inclined section.
L = Longest distance from the base to the inclined section.
S = Shortest distance from the base to the inclined section.

Data Sheet No. 64, The Foundry, April, 1910.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

The mills are by no means of special design, and can be purchased from several manufacturers. After the enamel has been reduced to a powder, it is screened in a rotary riddle and is placed in boxes such as are used on the second floor of the mill department. In these boxes the enamel is delivered to the enameling room. All the particles that do not pass through the screen are again put through the revolving mills.

The method of preparing the slush mixture is similar to that of preparing the enamel. The ingredients, consisting chiefly of borax and sand, are stored on the third floor, as well as in bins on the second floor, Fig. 1. The mixtures are made on the second floor and the material is melted in the same furnace as the enamel. After it is crystallized in the water tank, it is immediately placed in a wet mill and ground. This machine is the pebble mill, water being added, and the slush is discharged in the form of a grayish colored liquid. After grinding, the slush is usually permitted to "season" for a week, after which it can be applied to the castings. The liquid is thrown onto the casting from a cup and the casting is rocked from side to side while the liquid is draining off. Each piece should be carefully rocked until the excess of liquid has been drained off, to insure a uniform coating. It is advisable, however, to apply the slush with an atomizer, which sprays the liquid onto the casting more uniformly and greatly reduces the amount of slush used as compared with the other method. In addition, large sections, such as bath tubs, can be handled more quickly in this way. The slush room should be provided with a large exhaust fan operating near the floor level so as to carry off the excess slush, thereby making the room more comfortable for the operators. After the slush has been applied, the ware is set aside and is permitted to dry thoroughly. Pin holes are usually touched up by the enameler before the castings are placed in the furnace.

Seat Rings for Globe, Angle and Check Valves

BY F. W. BARROWS

THESE castings, made of bronze, are used in large quantities by valve manufacturers. As the same ring is usually made to do for the three varieties named and also for cross, safety and back-pressure valves, it will be seen that a single set (one size) of patterns will be much used and that it pays to have the patterns so made that the castings may be rapidly and cheaply produced. This means that they must be mounted on plates and molded by machine.

Fig. 1 shows one of the castings, consisting of a ring, *AA*, which is the seat proper, and the four (small sizes have only three or two) arms, *BB*, which support the central hub *C*. In finishing, this hub is drilled to suit the stem which is cast on the valve clapper or disk, and guides the clapper to its seat when the valve is closed.

Finishing the Rings.

In finishing these rings they are chucked by the inner diameter *D*, the chuck being slotted to receive the lugs *EE*, which serve to drive the work. They are then finished and threaded at F and turned at the shoulder *G* and diameter *N*. The valve body having been chucked and machined to receive the ring, it is screwed in by a plug similar to the chuck upon which it was machined, except that this plug, called the driver, is a loose fit at diameter *D*. The driver is mounted in the turret with the other tools for the body, and the ring is screwed in place by the lathe, being driven by the lugs *EE*. It is then bored at *D*, the hole through *C* drilled and reamed, faced and finally seated if for a cone seat valve. If the valve is to have a flat seat, the surface is finished for the seat.

In deciding how the pattern should be mounted it was at first thought that the casting could be made without using stools, by using a vibrator, as the arms have plenty of draft, but as the parting for the inside of the ring, which must be at the shoulder between diameters *D* and *L*, and follow the lower edge of arms, would leave very weak corners at *JJ*, which the vibrator might break, it was decided to use a stripping plate with stools; this made the vibrator unnecessary.

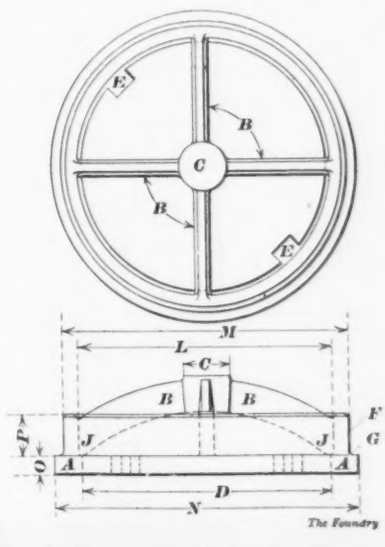


FIG. 1—PLAN AND SECTIONAL VIEWS OF SEAT RINGS FOR VALVES

This point settled, the details were left to the patternmaker, as was our custom, and these details will be explained in this article. The master patterns required for this set of rings are shown in the accompanying illustrations, which are similarly lettered.

The Pattern.

Fig. 2 shows the pattern for the ring *A*, combined with the block for supporting the pattern on the pattern plate *K*, Fig. 6. All necessary dimensions are given and the piece is finished all over except at *QQ*, Fig. 3.

Fig. 3 is the stool which goes inside of the pattern shown in Fig. 2. This stool is finished all over except at *QQ*. The crowned head fits the line of parting along the lower (as drawn) edge of arms *BB*, Fig. 1. This stool, after being turned to size and squared off to length, was slotted for the arms *B*. The slots were cut to leave knife edges at *RR*, at Fig. 3, that no sand might lodge here to interfere with the drawing of the patterns when in use.

Fig. 4 shows the mating stool, which in combination with the recess *S*, in stripping plate *T*, Fig. 6, forms the sand to match the parting located by the crowned end of the stool, Fig. 2., and its projection above the stripping plate *T*. It is understood that the convex end of Fig. 3 fits the concave end of stool, Fig. 4. This stool finishes all over except where marked *QQ*.

Fig. 5 is the pattern for the arms *BB*, and the hub *C*. It will be seen that

the lower edge (as drawn) is straight and not curved to match the lower edge of the arms in Fig. 1; and it is

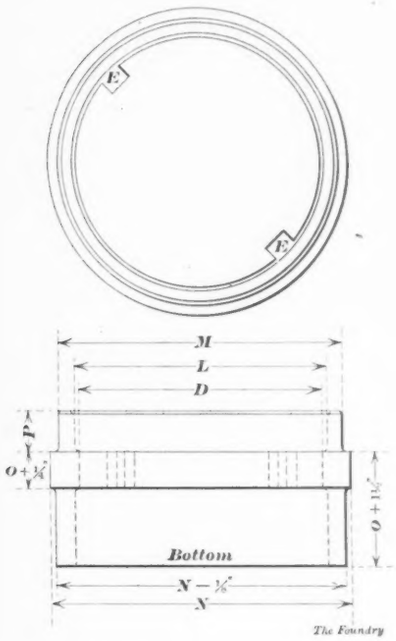


FIG. 2—PATTERN FOR RING, *A*, FIG. 1, COMBINED WITH THE BLOCK FOR SUPPORTING THE PATTERN PLATE

so made to strengthen the pattern and also to hold the stool, Fig. 3, in position. The depth may be anything considered necessary, and should enter stool, Fig. 3, not less than ¼-inch, but should not be so deep as to weaken the stool when the slots are cut to the necessary depth. This piece finishes all over. Pieces shown in Figs. 2, 3, and 4 were made of gray iron and Fig. 5 was made of hard brass.

Finishing the Pattern.

The finishing of parts shown in Figs. 2, 3 and 4, was done on the lathe with the work mounted on a face-plate. In preparing the pieces for the face-plate, they were gripped in a chuck, the bottom end was squared off and the inner diameter at the bottom end was bored true about ½-inch deep, to fit over a central plug fixed on the face-plate. All parts similar to Fig. 2 were made to fit the same plug and those similar to Figs. 3 and 4 were fitted to a second plug. If Fig. 2 is made first, the plug may be turned down to fit Figs. 3 and 4. Holes were drilled through the pieces near the bottom to provide shoulders for the straps which clamp the work to the face-plate. Two straps are used and they are made L-shape to avoid the need of blocking under their outer ends.

This method of mounting and holding the work enables the patternmaker to do all of the lathe work without rechucking. The pieces may be removed from the face-plate and replaced as many times as may be found necessary or convenient, and if they have been nicely fitted to the plug, they will always run true.

Fig. 2 was turned from the lower end of *N* diameter, over the top and down the inside to the bottom of *D* diameter; *N* diameter is straight, *M* diameter has a little draft and a fillet is left at the shoulder between the two diameters. *L* was turned to template the top, inner corner rounded and a fillet left at the shoulder between *L* and *D* diameters. The outer, top corner was chamfered 45 degrees to enter the box tool.

Fig. 3 was turned from the shoulder at the bottom of *D* diameter—straight, without draft—up over the convex end and bored to fit the central hub *C*. The convex end was turned to fit a template made from a drawing of Fig. 1. This piece was then sent to the machine shop to have slots for arms milled out as the pattern shop had no milling machine. They were also slotted for the lugs *EE*.

Fig. 4 was turned to *D* diameter—straight—and after squaring off to length (1½ inches — (0 + 1-100 inch) + ¾ inch + lift + ⅝-inch) from the face-plate (bottom end), the concave end was turned to fit the convex end of Fig. 3. It was our practice to make such pieces a little short, to avoid crushing, when the meeting cores were fragile, as

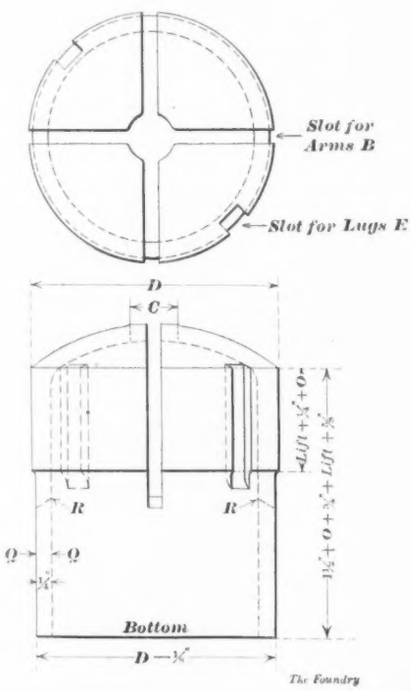


FIG. 3—STOOL PLACED INSIDE OF THE PATTERN SHOWN IN FIG. 2

is the case with the piece under consideration.

Fig. 3 having been slotted for the arms and returned from the machine shop, was used as a chuck for Fig. 5,

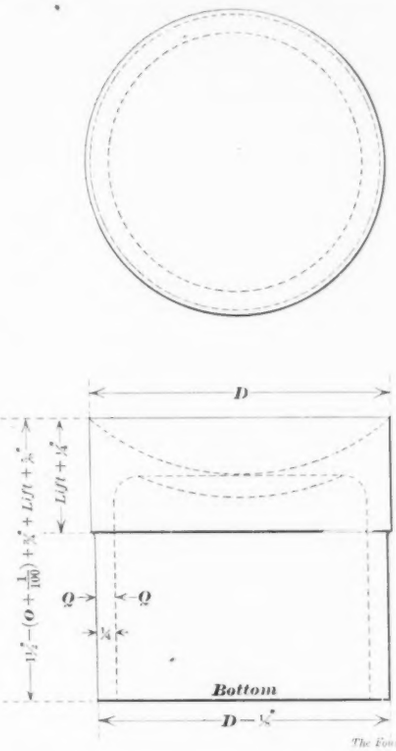


FIG. 4—MATING STOOL FOR THE ONE SHOWN IN FIG. 3

which pieces were first fitted to Fig. 3, leaving fillets where the arms joined the central hub *C*, and then soldered to Fig. 3, mounted on the face-plate. As Fig. 5 is rather light it needs the support afforded by Fig. 3 to hold the arms against the turning cut, which would otherwise bend them out of shape.

Each piece similar to Fig. 5 may be fitted and soldered to one of the stools as Fig. 3, the two pieces, Figs. 5 and 3, entered in one piece shown in Fig. 2, and then the three were clamped to the face-plate. Thus Fig. 2 may be tried over Fig. 5 and the fit tested, without removing from the lathe. Then as the stool, Fig. 3, fits Fig. 2, at diameter *D*, Fig. 5 may be fastened,—soldered and pinned—to Fig. 2 before Fig. 5 is released from the stool, Fig. 3. After this is removed from the completed pattern—made up now of Figs. 2 and 5—neat fillets of solder are formed where the arms join the ring.

Mounting the Patterns.

The finished patterns were then ready for mounting on the plates. A section of the plates and mounting are shown in Fig. 6. It will be understood that this illustration serves only to show

the method of mounting, all of the pieces being dimensioned in height, to suit the arrangement of plates. Dimensions of height from surface of stripping plate *T*, to the bottom end of the patterns and stools may be made whatever is necessary to suit the machine used. Any form of machine, which will operate stools, may be employed.

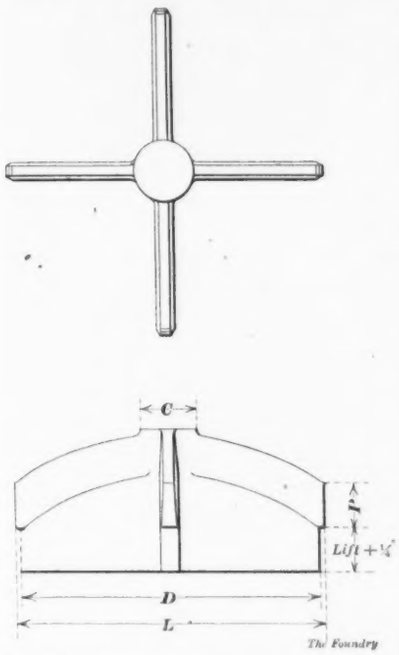


FIG. 5—PATTERNS FOR THE ARMS AND HUBS

Operation of the Pattern Plates.

The operation of the plates, as illustrated in Fig. 6, follows: When the molder is ready to draw the patterns, the pattern plate *K*, remains stationary and the stripping plate *T*, is raised with the flask and mold. The stool plate *U* being fixed to the stripping plate, goes up with it carrying the stools, Figs. 3 and 4, or, pattern plate *K* is dropped while stripping plate *T* and stool plate *U* remain stationary, which produces the same result, that is, the patterns are drawn from the mold while the stools support the cores.

When in place for ramming the mold, as is shown in Fig. 6, plates *T* and *K* are brought to their relative positions by adjusting screws, which, once set, fix the space from the top of *T* to the top of *K*. As *U* is fastened to *T* by distance bolts, it must always be at the correct distance from the surface of *T*.

The pattern, Fig. 2, is fastened to plate *K*, and the stools, 3 and 4, rest on plate *U*, but are not fastened to it. Set screws in *U* limit the lift by contact with bottom surface of pattern plate *K*. In this illustration it is plain that these set screws must project 5/8-inch above the surface of stool plate *U*.

Our practice was to fix the lift at 1/8-inch more than would clear the pattern from the mold. If the stools get dirty, as they surely will, and stick, the molder has only to operate the machine as in drawing the patterns, when the stools will be projected above the surface of plate *T*, and with most patterns the molder may lift them out and clean them. Stool *3* of this set could not be removed because the arms of *5* would prevent it, but this pattern is an exception to the general rule and usually all of the stools may be drawn up through plates *K* and *T* and the pattern, as well as stool *4* in this set.

This set of patterns will cost considerable, but can not be called expensive, as they will last many years, and barring accidents, will require very slight repairs. Similar patterns have been in constant use every working day since 1892, and are still in good order, which is partly due to the machine used—but that is "another story".

FRICTIONAL QUALITIES OF ALUMINUM.

By C. VICKERS

Question:—We would like to have a light aluminum alloy, also a mixture containing no aluminum, for discs to be used with a hard paper friction drive. The metal should possess good wearing qualities and should be cohesive, so that when the friction wheels are pulled against the discs they will grip without slipping.

Answer:—The usual casting aluminum alloys are used for this purpose as they are stiffer than pure aluminum and therefore come up to the requirements regarding rigidity, etc., and in addition are more easily cast. Pure aluminum possesses greater frictional qualities than its alloys, and if the discs are properly stiffened with ribs they will give better satisfaction as regards cohesion. If you decide to cast these discs of pure aluminum you will find it preferable to mold them with the face side down, the ribs being in the cope with a heavy riser taken from the hub. All corners at the junction of ribs, plate and hub should be carefully filleted. A good mixture for this purpose consists of copper, 7 per cent, and aluminum, 93 per cent.

The frictional qualities of aluminum are enormously increased by the introduction of silicon, but the casting difficulties are also enhanced. For this reason we hesitate to recommend its use. If you desire to try it, however, use 3 per cent of 10 per cent silicon-copper, 4 per cent of ordinary copper, and the balance aluminum. The paper covered wheels are frequently made of manganese bronze, a good alloy being made up as follows: Copper, 55 pounds; zinc, 36 pounds; manganese-copper, 2 pounds; tin, 8 ounces; aluminum, 5 ounces.

CORE WASH FOR CORES FOR BRASS CASTINGS.

Question:—We would like to have a mixture for a core wash for cores, which will give brass castings a smooth surface.

Answer:—This smooth surface is secured by the use of fine sand in making the cores, rather than by the application of a wash, which is not necessary and is rarely used on light castings. Where a heavy body of metal surrounds the core the latter must be protected by a heavy coating of plumbago. This coating is rubbed on with the finger, the plumbago being mixed to a paste with clear water.

We suggest the use of silica sand for your cores, with oil for a binder, and if the cores are made in whole boxes it may be necessary to mix varying proportions of molding sand with the sharp sand, so they can be handled when removed from the boxes. If you wish to use a wash, plumbago is the best. It should be mixed with weak molasses water and painted on.

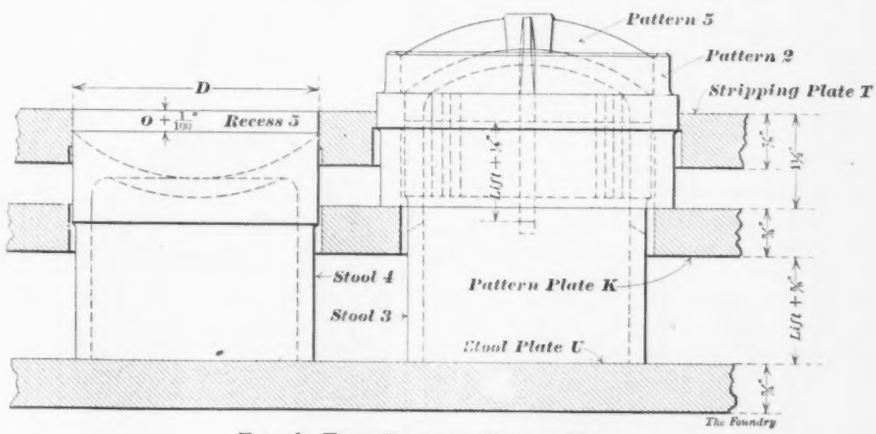


FIG. 6—THE PATTERN PLATES MOUNTED

DETROIT PREPARES FOR CONVENTION

An elaborate entertainment program has been outlined by the local committee
The exhibit of foundry supplies and equipment promises to be extensive

DETROIT foundrymen are rapidly completing arrangements for the reception and entertainment of the many visitors who will attend the conventions of the American Foundrymen's Association and allied organizations in Detroit, June 6 to 10. The Foundry and Manufacturers' Supply Association is likewise engaged in making preparations for the extensive exhibit, which promise to surpass all previous efforts. The foundrymen of Detroit have organized, Frank T. F. Stephenson having been elected chairman, and A. Preston Henry, secretary. The chairmen of the various committees are as follows: Frederic B. Stevens, finance; Joseph J. Wilson, plant visitation; James S. Keightley, reception; W. P. Putnam, convention sessions; DeLa-Motte Henry, ladies; Edward J. Woodison, entertainment, and Oliver Phelps, boat ride.

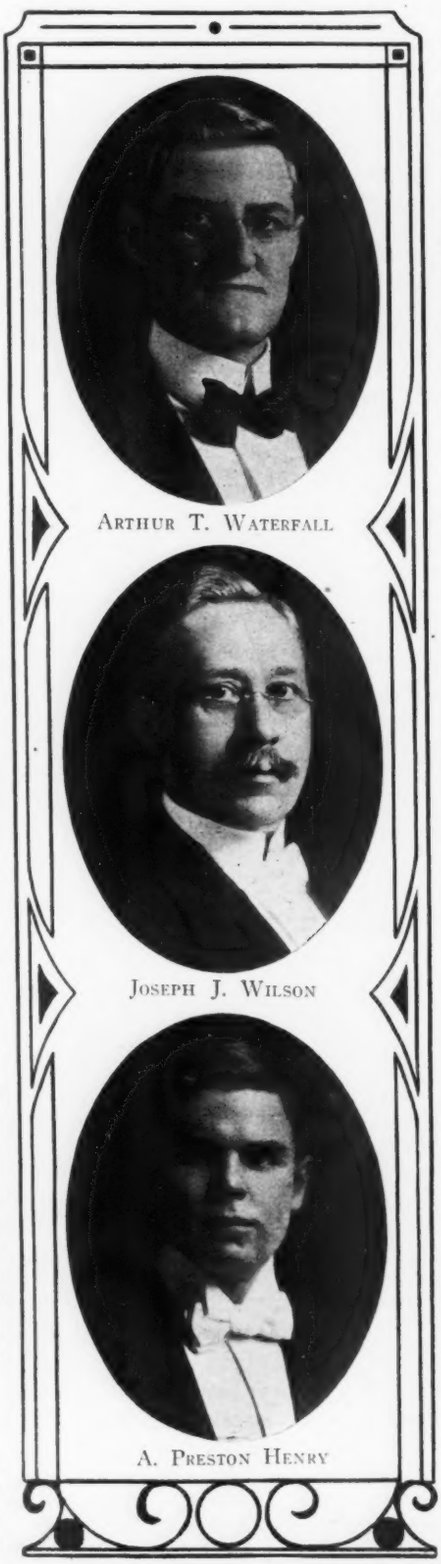
Entertainment Program.

The entertainment program reflects the hospitality of the Detroit foundrymen, and is as varied as it is extensive. The local committee will tender a complimentary dinner to the officers of the allied associations and to the technical press on Monday evening, June 6, at the Pontchartrain hotel. On Tuesday, June 7, the visiting ladies will be given a trip around the city, as well as a theater party. In the evening a smoker will be given at the Light Guard armory, which will be in charge of the entertainment committee, of which Edward J. Woodison is chairman. The boat ride on Detroit river and Lake St. Clair should prove one of the most enjoyable features of the convention. The probabilities are that the new steamer Ste. Clair will be placed at the disposal of the foundrymen, as she will go into commission just before the convention opens. At least 4,000 people can be accommodated, the boat leaving the wharf late in the afternoon and returning at midnight. Oliver Phelps, resident manager of the M. A. Hanna Co., will have charge of this feature of the entertainment.

Trips to Detroit Foundries.

Joseph J. Wilson, until recently superintendent of the Cadillac Motor Car Co.'s foundry, and who has been appointed superintendent of the foundry departments of the General Motors Co., as chairman of the plant visitation committee, is planning to give the delegates every opportunity to visit the many modern foundries which have done so much to make Detroit a prominent casting producing center, especially as regards the manufacture of gray iron, brass and aluminum sections for automobiles. Those desiring to visit certain plants should communicate with Mr. Wilson, so that suitable arrangements can be made. At the present time, there are no less than ten new foundries under construction in the "City of the Straits," three of which promise to be the largest of their kind in the world.

"The men behind the guns"



ARTHUR T. WATERFALL

JOSEPH J. WILSON

A. PRESTON HENRY

Association Headquarters.

James S. Keightley, superintendent of the Great Lakes Engineering Works, is chairman of the reception committee, and he will be assisted in his work by a large number of aides, who will devote all of their efforts to the visitors throughout convention week. The Detroit local committee will have its headquarters at the Pontchartrain Hotel, while the Associated Foundry Foremen will gather at the Griswold House. The Foundry and Manufacturers' Supply Association has selected the Cadillac Hotel, while the members of the American Foundrymen's Association and the American Brass Founders' Association will have headquarters at the Pontchartrain.

Convention Sessions.

W. P. Putnam is chairman of the convention sessions committee, and those who desire to make arrangements for any special features in connection with their papers should communicate with him at 1111 Union Trust building, Detroit. N. K. B. Patch is chairman of the committee on papers for the meeting of the American Brass Founders' Association and he reports that a number of excellent addresses have already been promised.

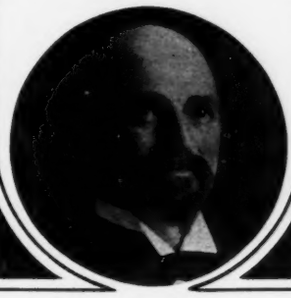
The date of the meeting has been arranged at a time when no other convention is being held in Detroit, thus offering the best possible accommodations to the delegates. The secretaries of the various societies report that the membership has grown rapidly during the year, W. M. Corse, secretary of the American Brass Founders' Association

EDWARD J. WOODISON

DE LA MOTTE HENRY

FRANK T. F. STEPHENSON

W. P. PUTNAM



JAMES S. KEIGHTLEY

reporting an increase in enrollment of over 50 per cent during the last year.

The Exhibit.

President F. N. Perkins, of the Foundry and Manufacturers' Supply Association, has called a meeting of the board of trustees for Friday, April 1, at the Cadillac Hotel. The exhibit of foundry supplies and equipment will be held at the Michigan State Fair Grounds, located in the extreme northern section of Detroit, approximately 12 miles from the center of the city. The buildings placed at the disposal of this organization already have proven too small for the space reserved, and two temporary structures will probably be built, one for the display of molding machines in operation and the other for melting furnaces. The amount of space reserved now totals 29,000 square feet, and it is estimated that no less than 35,000 square feet will ultimately be sold. One concern has reserved 4,000 square feet, while several exhibits will occupy no less than 2,000 square feet.

The following concerns have been admitted to membership in the Foundry and Manufacturers' Supply Association during the past 30 days:

The Adams Co., Dubuque, Ia.
American Combustion Co., New York City.
American Blower Co., Detroit.
Bayer Pattern Plate & Mfg. Co., Cleveland.
Buckeye Products Co., Cincinnati.
The Iron Age, New York City.
Pocahontas Coke Co., Cincinnati.
O. M. S. Co., Plainfield, N. J.
Scrutari Trust, Montreal.
Ohio Sand Co., Conneaut, O.

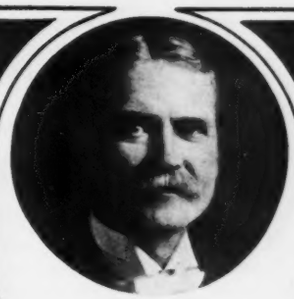
The headquarters of the general convention committee have been established at the works of the chairman, Frank T. F. Stephenson, 12-14 Atwater street, Detroit. Those desiring membership in the Foundry and Manufacturers' Supply Association or space reservations, can secure the necessary information from C. E. Hoyt, secretary, Lewis Institute, Chicago. Mr. Hoyt is likewise secretary of the Associated Foundry Foremen. The addresses of the other society secretaries follow:

Dr. Richard Moldenke, secretary of the American Foundrymen's Association, Watchung, N. J.

W. M. Corse, secretary of the American Brass Founders' Association, Lumen Bearing Co., Buffalo.

Detroit Association.

All of the members of the Detroit Foundrymen's Association will take an active part in the reception and entertainment of the visitors during Founders' Week. This society has had a wonderful growth and practically every foundry in the City of the Straits is represented among its members. The officers of this organization are as follows: Arthur T. Waterfall, president; Joseph J. Wilson, vice president; A.



E. I. CHASE

W. M. CORSE

MELVIN HENRY

F. F. BEAL

FRANK McMURDIE

Preston Henry, secretary; E. I. Chase, treasurer; F. F. Beall, W. M. Corse, Frank McMurdie and Melvin Henry, members of executive board.

The Gold Medal.

From Alfred E. Howell, the following communication has been received regarding the gold medal award:

We wish to most heartily applaud THE FOUNDRY's public spirit in donating a gold medal for the most notable achievement in foundry practice during the year preceding the award. While I believe improvements should be and will continue to be primarily for improvement's sake, just as virtue is for virtue's and art of art's sake, nevertheless its recognition has through all ages been deemed fitting and expedient for encouragement, even though the award be a laurel or wreath of bay, as in the old Greek days of Olympia.

The plan you outline seems to me excellent in every particular.

ALFRED E. HOWELL, vice president
American Foundrymen's Association.

CASTING WATER JACKETED CYLINDERS IN A HORIZONTAL POSITION.

BY WILLIAM GRANT JR.

A GREAT many foundrymen are of the opinion that the only successful way to cast jacketed cylinders is to stand them on end after they have been molded in a horizontal position. The writer, however, has cast a great many intricate water jacketed gas engine cylinders in a horizontal position, and has yet to experience a single failure. The success of the method depends upon proper cores, thoroughly washed, to prevent cutting, hot iron and proper gating.

Fig. 1 shows an 18-inch diameter by 28-inch stroke double-acting jacketed gas engine cylinder cast in a horizontal position. The casting measures 4 x 6 feet over all, is jacketed the full length and width and weighs 6,000 pounds. Fig. 2 shows a 12-inch diameter by 16-inch stroke single-acting cylinder. This casting measures 4 feet 6 inches by 3 feet, is also jacketed the full length and width and weighs 3,000 pounds. Fig. 3 is a cross section of the larger cylinder in the flask and shows the only anchors used. These are two ⅜-inch stem chaplets placed at each end to hold down the top half of the jacket cores.

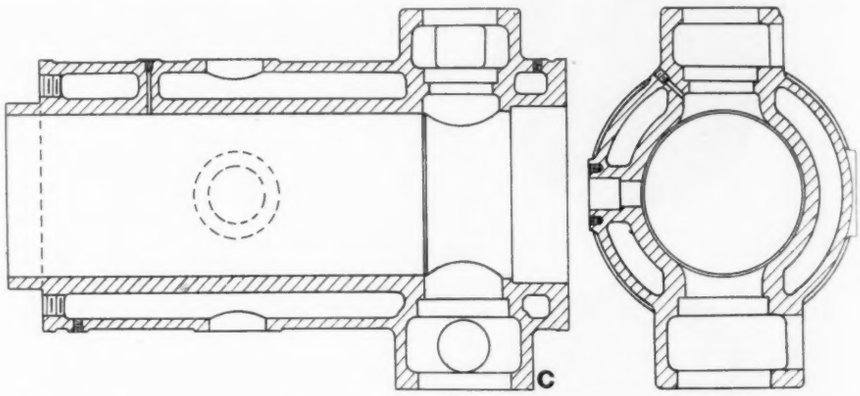


FIG. 2—SECTIONAL AND PLAN VIEWS OF A 3,000-POUND WATER JACKETED GAS ENGINE CYLINDER CAST IN A HORIZONTAL POSITION

The molds for these castings are made in dry sand in the ordinary manner. The cores for the jackets are all made of a very high grade silica lake sand with linseed oil for the binder. In order to prevent any tendency the jacket cores may have to cut, it is also essential to treat them with an asbestos core wash.

This wash is made up in the following manner: A common water bucket is filled about 65 per cent full of clean, powdered asbestos which contains a small proportion of magnesia. The asbestos may be cheaply procured from any plant making magnesia pipe covering. Enough molasses water is added to thoroughly soak up the asbestos, after which the bucket is nearly filled with silver lead blacking. The compound is then mixed thoroughly. After mixing, the wash, prepared in the manner indicated, is poured through a No. 10 riddle to strain out all the lumps. Two handfuls of soapstone are then mixed with the strained portion and the wash is ready for use. If sand containing a high percentage of silica cannot be obtained for the cores only one-third the amount of silver lead, noted above, should be used, making up the deficiency with pure silica.

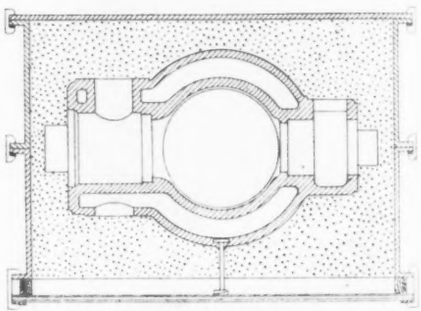


FIG. 3—CROSS-SECTION OF MOLD OF CYLINDER SHOWN IN FIG. 1

The cores are placed in the mold in the ordinary manner and two vents are taken off each half of the jacket through the cope, along with one vent from one end of the core. It will be found that the core sand rolls out easily and that the rods can be extracted readily, if ¼-inch annealed iron is used.

Referring to the illustration, it will be seen that the mold for the larger cylinder is gated at two points, designated A and B in Fig. 1, and the smaller cylinder is gated at C, Fig. 2. Risers are placed at the highest points. The iron is poured as hot as possible, 300 to 400 pounds being flushed through to insure a clean, sound casting.

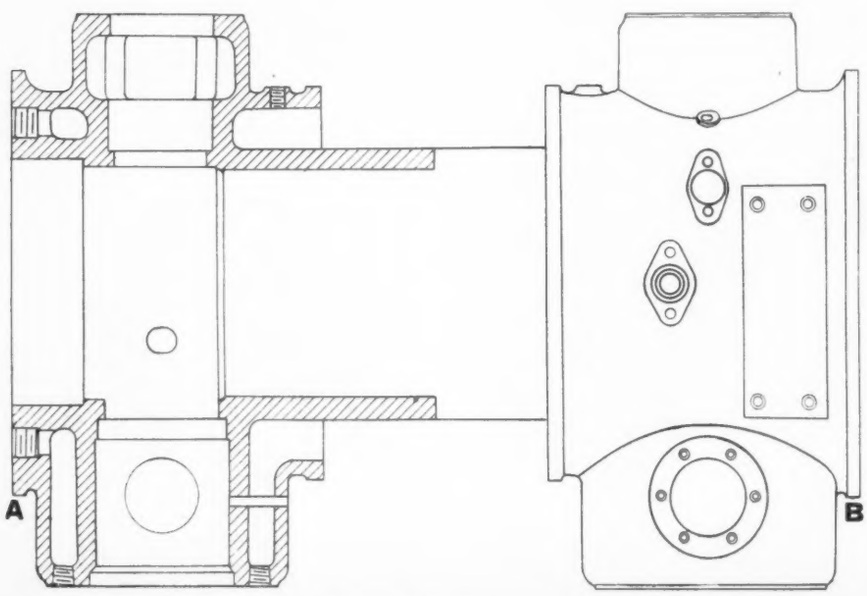


FIG. 1—WATER JACKETED GAS ENGINE CYLINDER CAST IN A HORIZONTAL POSITION

SEGREGATION IN STEEL CASTINGS*

Observation of this phenomenon with a discussion of the value of microscopy and synthetic chemistry in metallographic investigations

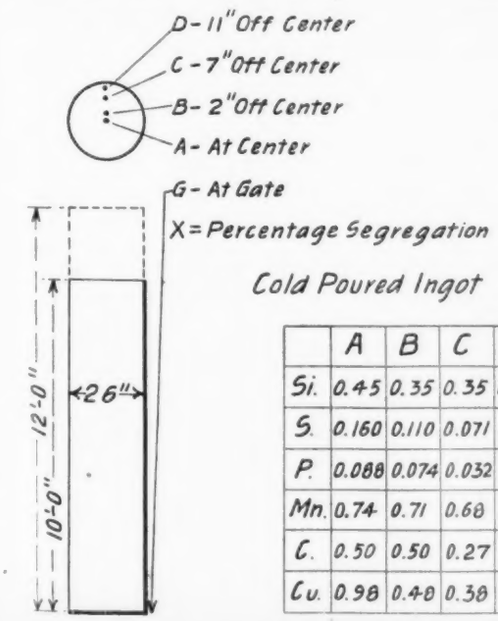
BY S. S. KNIGHT

SOME 14 years ago, the subject of "segregation phenomena" in cast iron was quite thoroughly investigated by the writer. The results which he published at that time were somewhat unsatisfactory, owing to the fact that in cast iron the amount of free carbon present is a factor which not only greatly hampers observation mechanically, but is of no small importance in affecting the results themselves. In steel which has undergone work, the observation of segregation phenomena could not possibly give as satisfactory results as in ingots or castings which have had no work done upon them, because the soaking, rolling or hammering all tend to more or less counteract the effect of segregation, both mechanically and chemically. Steel, which is cast in sand molds, has long been looked upon as more or less of an uncertainty for the purpose for which it is intended, unless very large factors of safety are allowed, on account of the almost complete impossibility of getting castings which are homogeneous. This lack of homogeneity comes about primarily from the occlusion of certain gases or foreign substances, such as dirt or slag, in the material itself while in a semi-molten or plastic condition, as well as from segregation.

The killing of steel, as it is popularly termed, is unquestionably one of the hardest things to satisfactorily accomplish in the steel casting business. If basic practice is being used, the fact that you have a slag covering the molten metal in the ladle, which is hungry for all acid-forming elements, means that it is beyond human possibility, so far as is now known, to keep your steel during pouring, of the same chemical composition. The writer has seen many basic heats running from 50 to 100 tons, poured from a single ladle, where the silicon content varied 400 to 500 per cent, from samples taken from the first and the last of the pouring, and yet the total amount of time consumed in the operation was less than half an hour. In some casting plants, the metal is tapped into a receiving ladle mounted upon trunnions, and the basic slag skimmed, and thus largely disposed of before being poured into the crane ladle, and from which it is teemed into the molds. This partially obviates the difficulties encountered from the basic slag, but tends to cool off the metal in the ladle. The Talbot process, or any of its analogues, which does all of the refining in the basic furnace, and then allows the molten steel to be transferred to the acid furnace, to be there held so that the majority of the gases may escape from the bath before having the additions made, is probably the nearest approach to perfect practice which the open-hearth industry will be able to develop, and which is applicable to large quantities of metal. Even this, while not as expensive as the after-treatment in an electric furnace, as is now being done in some four or five plants in the United States, is still too costly for the ordinary purchaser of steel castings. The reducing atmosphere of the electric furnace, as well as the tremendous agitation of the bath, caused by the passing of current through it, in all of the resistance types, necessarily tends to produce a steel of great purity, if the additions are properly made.

In acid practice, the absolute inability to lower the sulphur and phosphorus content, necessitates the use of high grade material, for which, of course, manufacturers have to pay a premium. On the other hand, acid steel, if properly made, should leave the furnace hearth almost free from absorbed gases, and before the pouring commences, should be thoroughly killed, and capable of producing castings which are free from blow-holes which would arise from the composition of the steel itself. Of course the matter of blow-holes arising

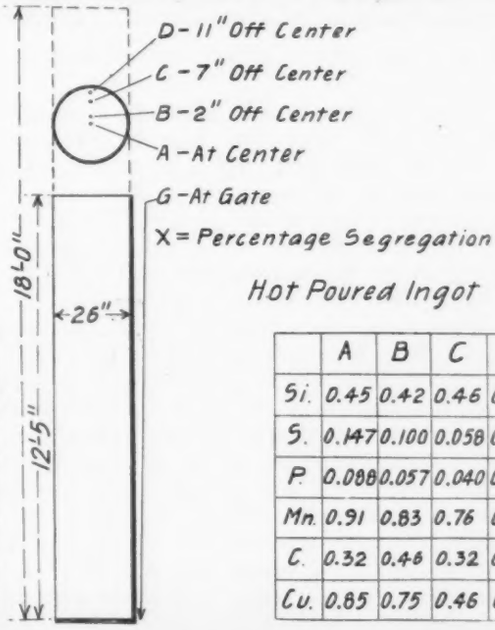
*Presented at the March meeting of the Philadelphia Foundrymen's Association.



Cold Poured Ingot

	A	B	C	D	G	X
Si.	0.45	0.35	0.35	0.34	0.34	32.5
S.	0.160	0.110	0.071	0.051	0.052	208
P.	0.088	0.074	0.032	0.021	0.020	340
Mn.	0.74	0.71	0.68	0.68	0.61	21.5
C.	0.50	0.50	0.27	0.21	0.21	138
Cu.	0.98	0.40	0.38	0.24	0.47	108

FIG. 1—SEGREGATION IN A COLD POURED CASTING



Hot Poured Ingot

	A	B	C	D	G	X
Si.	0.45	0.42	0.46	0.38	0.34	32.5
S.	0.147	0.100	0.058	0.047	0.052	183
P.	0.088	0.057	0.040	0.032	0.030	193
Mn.	0.91	0.83	0.76	0.72	0.61	49.25
C.	0.32	0.46	0.32	0.22	0.21	148
Cu.	0.85	0.75	0.46	0.25	0.27	215

FIG. 2—SEGREGATION IN A HOT POURED CASTING

from improper sand mixtures, or dirt-holes coming from improper closing or dirty molds, are simply matters to be rectified by attention to detail in the molding shop. Probably a great deal of the trouble, which producers of steel castings, who use the acid process, have today, is due to the fact that the additions made in the furnace or ladle are not of the right composition, or are not properly made, and such expedients as aluminum shot for use in the heads and gates, are of very little value, because there should be no call for their use, as when the necessity for them arises, it simply means that the practice in some previous operation has been lamentably bad.

Now, in Bessemer practice, the steel is poured at a much higher temperature, and as a result, piping is aggravated, and shrink-holes and check-cracks more likely to occur. The additions, however, are very much more apt to be taken up by the mass of metal and thoroughly disseminated through it, owing to the fact that the temperature of the bath is higher and that the material has been in a state of such tremendous agitation. The heavy losses experienced, however, by the ordinary manufacturer making castings by the Bessemer process, is such that the majority of the people who attempt to do this commercially, are usually disappointed in the results which they get in a financial way. The low cost of installation, or facility with which this method adapts itself to intermittent production, makes it seem very desirable to the uninitiated; but as a general thing, experience seems to be showing producers of steel castings that Bessemer plants are operated to the best advantage when they are maintained as auxiliaries to large open-hearth establishments, where work of the most desirable character for this process can be furnished to them.

In the crucible steel industry, the possibility of steel being properly killed, is probably less then in any of the processes formerly described, owing to the fact that in America the production of crucible steel castings is today very largely in the hands of people who have recently gone into the business, and who know absolutely nothing of the technique of the steel industry, and who consequently cannot be expected to get the best out of the process which it is able to give. Unfortunately, its best, when graphite or black lead crucibles are used, cannot be as good as that of the acid, Bessemer or open-hearth processes described, owing to the fact that if the steel is held in the crucibles after the additions are made, a sufficient length of time for the bath to be properly killed, the life of the crucible is so reduced that this process of production becomes very expensive. Probably of all the steel cast in America today, crucible steel, as it is made and sold in the shape of castings upon the open market, is by far the least homogeneous. Now, leaving out of consideration all causes of the lack of homogeneity other than segregation, we find that five elements are most vitally concerned in this phenomenon: Sulphur, phosphorus, manganese, carbon and copper; and all are subject to great segregation in bodies of steel when cooling.

Fig. 1 shows a casting weighing approximately 22,000 pounds, and serves well to illustrate several points not heretofore very clearly explained, as far as we know. This casting was drilled at the gate *G*, where the metal practically set as soon as the pouring operation was completed, and where no chance for segregation occurred and also at the points *A*, *B*, *C* and *D*, these places being located at the center, and 2, 7 and 11 inches off center respectively. The transverse plane from which these drillings were taken, was at the extreme upper part of the solid portion of this casting, the piping taking up all of that part beyond this and the head. Other than this piping, there was no evidence of lack of mechanical homogeneity in this material. This casting was poured on end, and into the ladle was added all of the steel plate, amounting to about 12 per cent of the total weight of the bath which the molten metal would take up, and this plate was added at the time the metal was tapped from the furnace. In making these castings, no effort was made to in any way retard or diminish the shrinkage of the steel or the segregation of the elements mentioned. The piped portion of this ingot amounted to 17.75 per cent of its total weight.

Fig. 2 represents another casting made in the same way, but which was poured just as hot as it was possible to get the material in an acid furnace. You will note that the piping which extends in the case of the cold-poured ingot through just 16.66 per cent of its total length, in the hot-poured ingot extends through 30.5 per cent of its total length. The piped portion of the ingot was 27.5 per

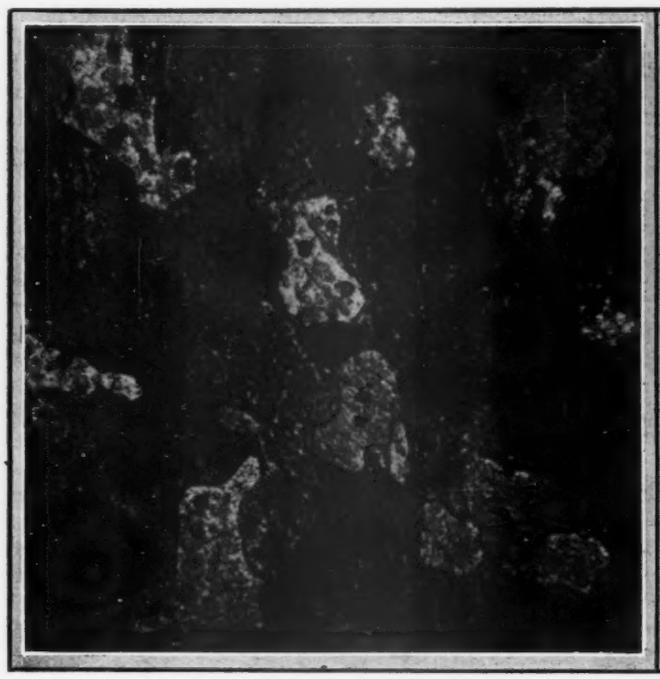


FIG. 3—IRON SULPHIDE CRYSTALS IN REFINED IRON

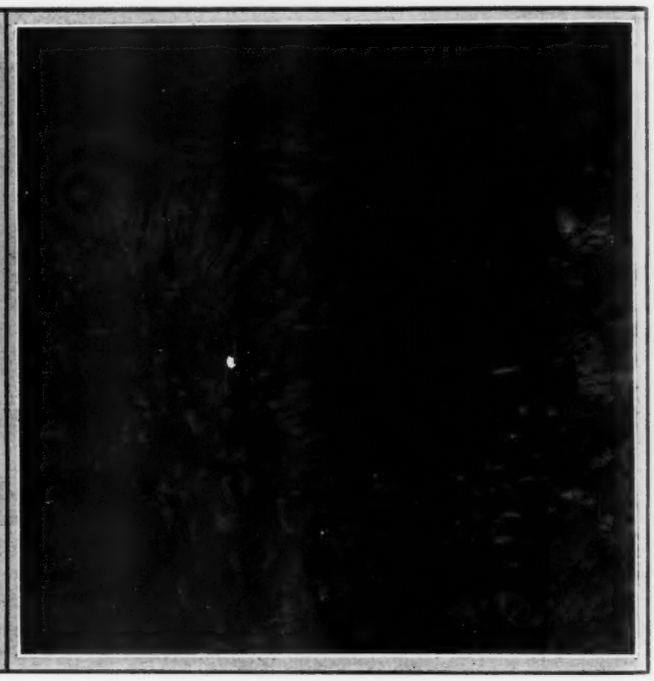


FIG. 4—PHOSPHIDE OF IRON (Fe_2P_3) IN STEEL

cent of its total weight. Inasmuch as both of these were cast in absolutely dry molds, this seems to show conclusively that the colder the metal can be poured into any casting, the less piping and shrinkage there will be when the metal sets. Now, by looking at the analyses of the drillings which came from this hot-poured ingot, the location of each sample being analogous, as we described for the cold-poured ingot, you will notice at once that the hotter the material is at the time the casting is poured, the less the tendency to segregation. For instance, in these two ingots, the tendency to segregate was identical as far as the silicon was concerned, or 32.5 per cent. In the cold-poured ingot, the segregation in sulphur amounted to over 208 per cent, in phosphorus to 340 per cent, in manganese to 21.5 per cent, in carbon to 138 per cent, and in copper to 108 per cent. In the hot-poured ingot, the segregation in sulphur amounted to 183 per cent, in phosphorus to 193 per cent, in manganese to 49.25 per cent, in carbon to 148 per cent, and in copper to 215 per cent. Now, by comparing these figures, it seems reasonably certain that as far as the silicon and carbon are concerned, the segregation is not much affected by the temperature at which the metal is poured. The sulphur and phosphorus would seem to segregate much more in metal which is poured cold than in metal poured at a higher temperature, while the tendency to segregation in manganese is directly the opposite. In copper, however, it would seem that the metal poured hot shows a far greater segregation than the metal poured cold.

These figures, in the light of what has been published within the last few years upon the phenomena of segregation, would seem to show that many of our popular theories are decidedly at variance with the facts. In the first place, the slow and gradual cooling which is supposed to prevent segregation, does so with only certain elements; or, at least, this is the deduction which would necessarily follow from the figures given above. In the next place, the keeping of a perfect heat condition in the fluid or semi-fluid metal, would probably tend to eliminate a large proportion of the segregated impurities, provided the temperature of the upper part could be so regulated that the extreme upper surface was the last to cool or set; in other words, that the cooling would take place, starting at the bottom and slowly rising to the top, and in a regular manner. As to how this is to be accomplished, we certainly cannot form any idea. It would seem in any ordinary casting that probably the greatest cause for segregation would be the throwing out of the impurities toward the center as the material sets. In the ordinary casting, the probability is that in a very large percentage of cases, the whole casting sets at almost the same time, and consequently the material is fairly homogeneous from a mechanical standpoint. Of course, large die blocks, forging ingots and pieces of such nature, would be exceptions to this rule. It would be very interesting to study the segregation of a large sand-cast ingot, providing it was split longitudinally through the center, a series of drillings being carefully made, and analyses accurately determined.

By observing the analyses of the drillings taken from the several points, it will be noted that of all the elements, sulphur, phosphorus and copper, show the greatest tendency towards segregation. In the case of sulphur, the writer is almost positive that all of this element which occurs in steel is in the form of iron sulphide of the chemical composition FeS. In cast iron, he believes that a portion of the sulphur is in the form of FeS_2, and this is true with all forms of iron in which the amount of graphite or free carbon exists to any appreciable extent. This assumption is based upon the fact that in order to get the maximum amount of sulphur by the evolution method, out of pig iron or cast iron, it is necessary to roast the sample, as was described by the writer in 1903. Now, this roasting is of no avail in the ordinary carbon steels, so far as the writer knows, and he has never been able to get higher results by the use of this method on that class of material.

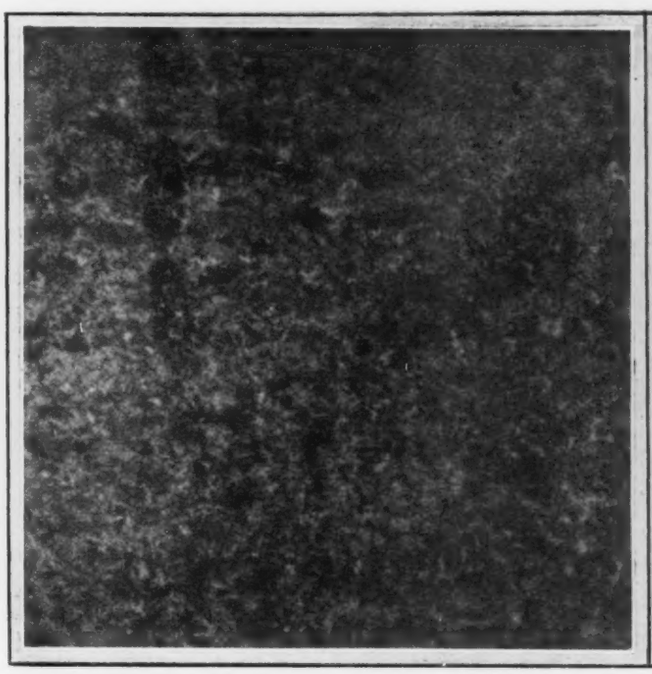


FIG. 5—PHOSPHIDE OF IRON (FeP) IN STEEL

FIG. 6—PHOSPHIDE OF IRON (Fe_3P) FROM METEORITE.

The photo-micrograph shown in Fig. 3, shows a very mild refined iron, having the following composition:

Silicon	0.188 per cent
Sulphur	0.203 per cent
Phosphorus	0.020 per cent
Manganese—None	
Carbon	0.02 per cent
Copper—None	

This specimen was etched in nitric acid, and the crystals of iron sulphide show very plainly, although the magnification is only 86 diameters. In cast iron, the writer was never able to isolate the sulphides metallographically. It is further

his belief that in all steel, the sulphur tends to segregate, and these segregations are one of the most fruitful causes of failure known to the steel industry. It would consequently seem a very wise provision on the part of the American Society for Testing Materials in limiting the sulphur content to a maximum of 0.050 per cent.

In regard to the segregation of phosphorus in iron, the writer is of the opinion that there exists in all carbon steels, the possibility of the occurrence of three distinct and separate phosphorus compounds. The first of these is shown in Fig. 4, which is a photo-micrograph of a very high phosphorus steel, the analysis being as follows:

Sulphur	0.170 per cent
Phosphorus	11.08 per cent

This material had no carbon, manganese, silicon or copper in it. These peculiar crystals seem to be monoclinic, and their arrangement is characteristic of this compound of phosphorus and iron. From experiments which the writer has conducted, he believes that the formula for this phosphide is represented by the symbol Fe_2P_3. The magnification shown in the photo-micrograph is only 86 diameters. These crystals are very soft, and they crumble readily and break almost in any direction. Practically all of them show signs of cleavage transversely, such cleaving planes usually being separated four or five times the diameter of the crystals.

You will readily see from the photo-micrograph that this peculiar style of arrangement tends more to structural weakness than probably any other which could be shown.

The next photo-micrograph, Fig. 5, shows another phosphide of iron taken from a lower phosphorus steel, where there was no carbon, silicon or manganese present. The sulphur was 0.128 per cent, and the phosphorus was 9.600 per cent. The magnification shown is 86 diameters, and these crystals are fairly hard and do not easily crush. The writer believes this material to have formula FeP, although some of his experiments led him to believe that the prosphorus content would be sometimes much less than that shown by the above formula.

The next photo-micrograph, Fig. 6, illustrates another phosphide of iron, a single crystal being shown. This particular phosphide was first shown to the writer by Wirt Tassen, as isolated from a meteorite, but the magnification which he used was very much higher than that shown in this photo-micrograph, and it leads me to believe that there is a possibility that there is still another phosphide of iron which is sometimes present in which the phosphorus content is as low as the formula shows. The analysis of the specimen shown is—

Sulphur	0.085 per cent
Phosphorus	3.88 per cent

silicon, manganese, carbon and copper being absent. The magnification shown is 340 diameters, and Mr. Tassen states that the formula for this phosphide is Fe_3P.

The segregation of manganese in cast steel has been for many years one of the most elusive phenomena of which the observation was ever undertaken by the writer. This element seems to possess the power to combine with sulphur at the high temperature of molten steel, or anything above 1,200 degrees Cent., and to form a very light slag, which is immediately thrown to the surface. Instances are on record of where material containing as high as 0.400 per cent sulphur, loses 75 per cent of its sulphur content at once upon the addition of 2 per cent of high grade ferro-manganese, the same being stirred into the mixture in the form of a powder. The crystal shown is one of a number which the writer has found in cemented steel only under high magnification, which he believes to be a crystal of manganese sulphide having the formula MnS. These crystals are harder than soft cemented steel, and in polishing, stand above the rest of the surface, and so take a light, iridescent sheen just before the main surface of the section comes into focus under the microscope.

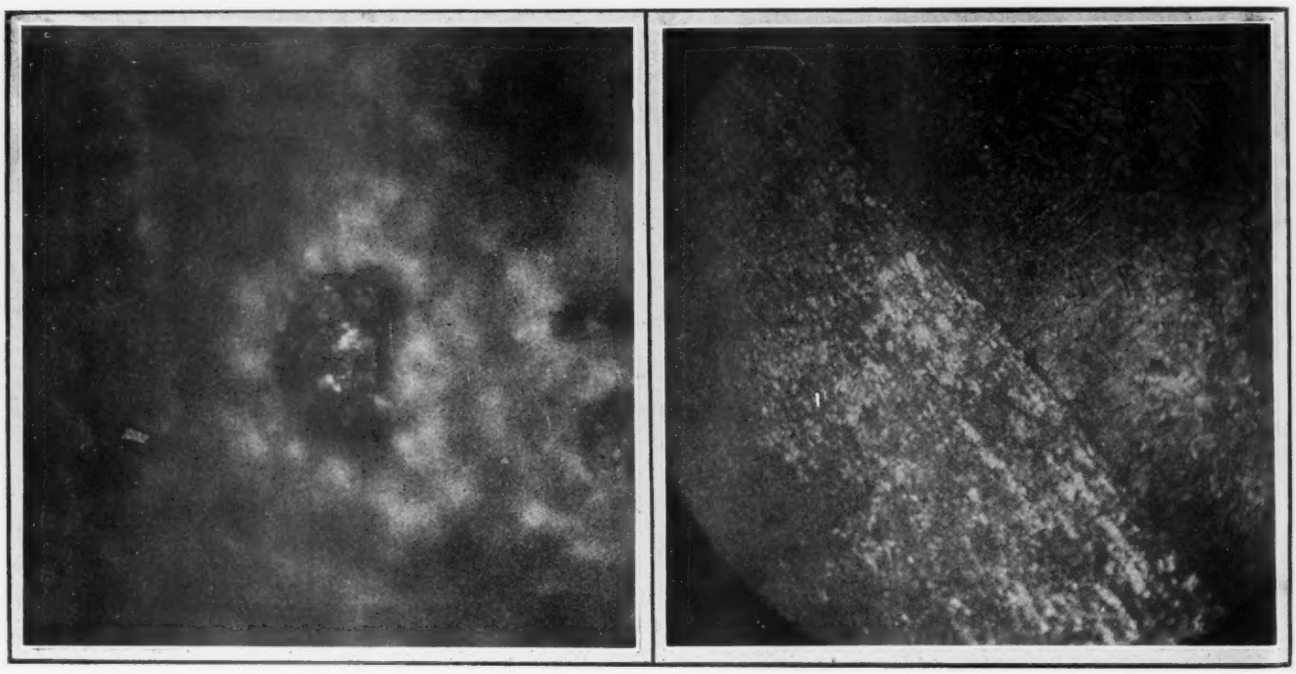


FIG. 7—MANGANESE SULPHIDE IN CEMENTED STEEL.

FIG. 8—ALLOY FILM IN COPPER CLAD STEEL ROD (86 DIAMETERS)

The next photo-micrograph shown in Fig. 7 is from a sample running as follows, the crystal seen being characteristic of this form of manganese compound:

Silicon	0.600 per cent
Sulphur	0.175 per cent
Phosphorus	0.045 per cent
Manganese	0.080 per cent
Combined carbon	0.82 per cent
Temper carbon	1.82 per cent
Copper	0.080 per cent

This specimen is etched with nitric acid.

In regard to the silicon content in iron and steel, so far the writer has been unable to isolate, either metallographically or chemically, any silicon iron compound. Since its percentage of

segregation is so small, it naturally leads us to believe that if the solid solution theory could be applied anywhere, it would be more applicable to silicon than to any of the other elements.

In regard to the copper existing in steel, Fig. 8 shows the so-called alloy film in a sample of copper-clad steel rod. The copper sheathing of this rod was as nearly pure as it would be possible to get copper, running 99.37 per cent. The steel itself analyzed as follows:

Silicon	0.100 per cent
Sulphur	0.018 per cent
Phosphorus	0.020 per cent
Manganese	0.55 per cent
Carbon	0.170 per cent
Copper	0.06 per cent

The alloy film itself is shown in detail in Fig. 9, which is simply a higher magnification of the sample shown in Fig. 8, the latter being 430 diameters, while the former is 86 diameters.

Fig. 10 shows a sample of copper steel containing 0.013 per cent silicon, with 15.96 per cent copper, and practically no sulphur, phosphorus or carbon. The crystals shown, the writer believes to be iron cupride, having the formula Fe_2Cu_3. The specimen is etched with picric acid. The magnification shown is 48 diameters.

In the investigation of the segregation of the metalloids in carbon steels, there is certainly one of the most faithful fields of research open today in the metallurgical world. As far as the writer knows, the photographs here shown are the first ever published of the sulphur, phosphorus, manganese and copper compounds of iron as found in manufactured material. The investigation of such phenomena as fatigue will also bring forth results of the most practical nature. From what work the writer has done individually he is led to believe, on account of the inability of anyone to isolate the compounds of phosphorus, sulphur, silicon and copper, when these elements exist in percentages of less than those specified by the American Society for Testing Materials, that it seems only probable that perhaps something similar to what is known as solid solution may occur under these circumstances. However, this would be very hard to prove, inasmuch as it would be almost impossible to find these compounds, even if they did exist in steels which contained them in small quantities.

The carbon iron compounds are already thoroughly isolated metallographically, and a good deal is known about them chemically, and this is so much a matter of common knowledge that it is not worth while to take up time with it now, as all of the standard works (particularly that of Floris Osmond) are very comprehensive upon this point.

In conclusion, too much stress cannot be laid upon the importance of a thorough investigation of this field by a number of independent workers, so that the results obtained may be properly tabulated and inferences drawn, which will be much more comprehensive and correct than are now possible, owing to the small amount of information available at the present time. It seems that in this particular field, the most is to be expected out of the investigations which will be made in the future, since the use of iron and steel is becoming more common every day, and will become more so, as lumber of all kinds each year is harder to get and the supply more limited. The tremendous reduction in price which has been made within the last three or four years in microscopic apparatus, and the ease with which it can be obtained, all point toward a very much greater number of investigators in this field in the near future. To the investigator, a knowledge of analytic and synthetic chemistry is absolutely essential, if he is to accomplish anything in the field of metallographical investigation. However, this knowledge is so easily obtained, not only in our schools, but also in the laboratories of our large industrial plants, that there is reason to believe that investigations along these lines will be more active and that the results achieved will fully repay anyone for the labor and sacrifice made.

FIG. 9—HIGHER MAGNIFICATION OF SAMPLE IN FIG. 8 (430 DIAMETERS)

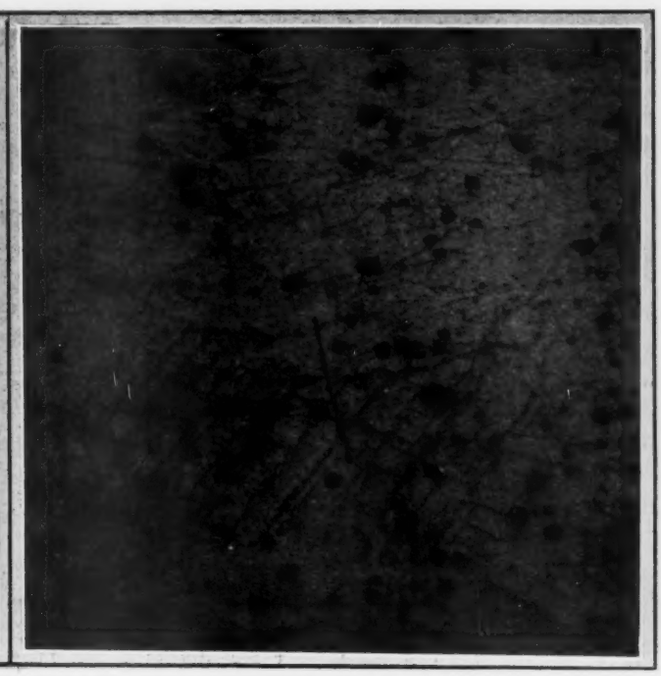


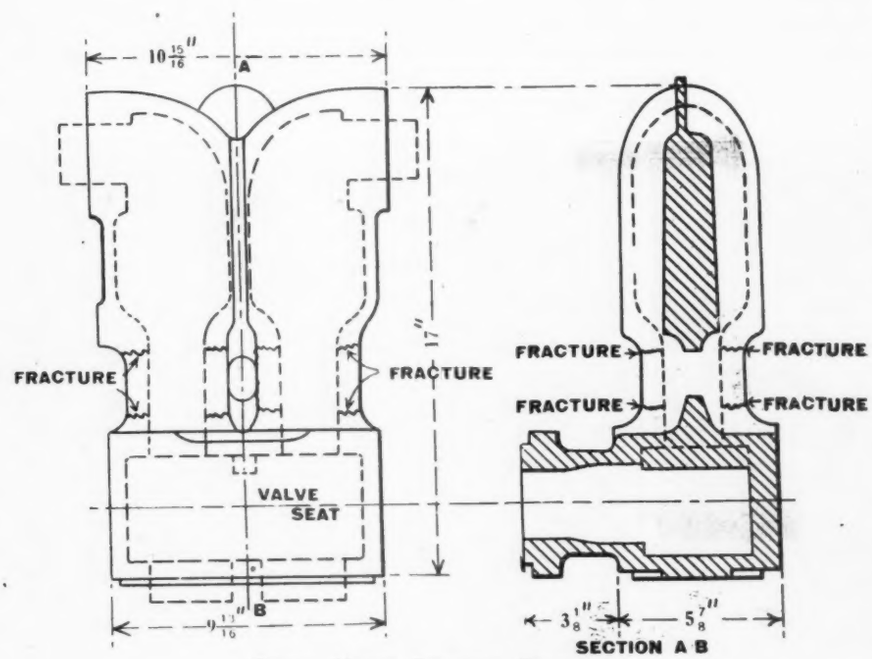
FIG. 10—IRON CUPRIDE IN COPPER STEEL

MELTING BRONZE WITH PRODUCER GAS.

Successful experiments have been conducted in the melting of bronze in a gyrating flame crucible furnace, built by the Kroeschell Bros Co., Chicago, at the plant of the Westinghouse Machine Co., East Pittsburg, Pa. In the experiments the temperatures attained, as shown by pyrometer, were 2,800 degrees Fahr. and upward, using 125 B. T. U. producer gas as fuel. It is claimed by the manufacturers of this furnace that this is the first successful experiment of its kind in which low B. T. U. producer gas was burned without first pre-heating the gas and air.

THE RUPTURE OF A BRASS VALVE IMMEDIATELY AFTER CASTING.

Question:—The accompanying illustration shows a locomotive boiler check valve which is giving us considerable trouble. The original castings, which we are replacing, were solid through the center, the valve chambers having been bored out for a steam valve, and the metal thicknesses were uniform. We decided to change this for the use of a wing instead of a stem valve, and the thicknesses of the walls of the valve chambers were increased. This disproportioned the metal in the ratio of one to three, with an extra heavy body of metal in the center. We poured the casting from the end *A*, a large riser head having been placed in the center. This casting, when bored, showed a crack extending through the heaviest portion from one valve chamber to the other. We then changed the design on the outside, and cut an oblong opening through the middle to proportion the metal thicknesses as much as possible. This casting cracked through all four walls, as indicated. These cracks were formed while the casting was hot, which was plainly shown by the fracture. We then placed a 5/8-inch web in the center and uncovered the heavy part of the casting in both the cope and drag, and cut out the core from the flange end extending through the valve chamber, as far as *D*. This casting cracked through one side of the web and through both chambers. The casting weighs 115 pounds and we cannot reduce the pattern any more or the metal will be too thin in the valve chamber. We use the following mixture: Copper 225 pounds, tin 16 pounds, lead 12 pounds. The metal is melted with fuel oil in a crucible.



CHECK VALVE SHOWING FRACTURES

Answer:—Your difficulty is due to the fact that the heavy portion of the casting remains liquid long after the comparatively lighter ends have set. When the metal begins to set, the casting shrinks and to do so the center must drag the heavy, solid ends together. As it has not the strength to do this, a rupture of the metal occurs at the moment of solidification. This explains why uncovering the casting and digging out the core failed, as these operations could not be performed until the metal had set, and then it was too late to save the casting. It seems, therefore, that if the casting were poured upright the trouble would disappear, as the weight of the upper portion would press down upon the center while the latter was solidifying and would thus prevent all possibility of rupture. If not convenient to pour vertically, incline the mold from the pouring end, solidify the runner as quickly as possible, and then "up-end" the mold. This operation, to be effective, must be performed, however, before the center has become solid.

The Indiana Brass & Iron Bed Co. has installed two five-ton Newten cupolas built by the Northern Engineering Works, Detroit.

RED MANGANESE BRONZE.

By C. VICKERS

EVERY once in a while we run across formulae for red manganese bronze reading something like this: Copper, 84 per cent; zinc, 4.5 per cent; tin, 6.5 per cent, and manganese, 5 per cent. This is recommended as suitable for propellers, spur wheels, etc. Another one is: Copper, 82 per cent; tin, 8 per cent; zinc, 5 per cent; lead, 3 per cent, and manganese, 2 per cent. The third consists of copper, 83.5 per cent; tin, 8 per cent; zinc, 5 per cent; lead, 3 per cent, and manganese, 0.5 per cent. The latter two are supposed to be used for castings for hydraulic machinery. Of the four alloys, the one last named is the only one that can be cast as stated, and even in this the percentage of manganese is too high. The other alloys cannot be cast in sand without the use of aluminum, because the manganese oxidizes so rapidly that the castings are full of "cold shuts," no matter how hot the metal is poured.

This is caused by a film of oxide, which forms on the surface of the molten alloy and is being continually folded in as the metal runs into the mold, forming the "cold shuts" mentioned. Aluminum will remedy this condition, but even then an alloy containing such a high percentage of manganese, tin and zinc, as the first one is too hard to be of any practical use. The quantity of manganese used in copper-tin alloys must be very small, so as not to discolor the casting, but even then phosphorus is preferred as a de-oxidizer for general work.

CHEAP YELLOW BRASS.

Question:—We would like to have a cheap mixture for yellow brass, gasoline engine exhaust and intake pipes. We are using a mixture containing copper, 65 per cent; zinc, 35 per cent and lead, 4 per cent. The castings are about 3/32 inch thick, and we have trouble in running them.

Answer:—The addition of 5 ounces of aluminum to this mixture will overcome your difficulties. If you desire to reduce the cost of this mixture, you can do so by adding more zinc, as it will then carry 5 per cent more zinc and 5 per cent less copper.—K. K.

The B. F. Sturtevant Co., Hyde Park, Mass., is sending a circular to the trade describing its portable electric dust blowing set. It consists of a pressure fan incased in aluminum, driven by a direct-connected electric motor, which can be operated from ordinary lamp sockets.

EQUIPMENT OF A MODERN BRASS SHOP

Including a description of novel, tilting oil furnaces and ladle heaters --- Construction and general arrangement of the foundry

BY C. VICKERS

LAST few years have witnessed almost revolutionary changes in foundry practice. Compressed air has played an important part in this evolution and has made it possible to use power for ramming molds, cleaning castings, drawing patterns and melting metal. Even that time-honored institution—the brass foundry—has participated in this change, and the air nozzle has supplanted the bellows, and the vibrator the pounding fists of the molder in lifting off copes and drawing patterns, resulting in a greatly increased output and a corresponding decrease in the cost of castings.

The rapid strokes of the vibrator make it possible to lift off the mold from patterns that otherwise would have to be drawn, thus eliminating rolling the mold, swabbing the pattern, patching broken corners and cleaning and blowing the superfluous sand from the mold. The molder, therefore, has the time these various operations would have taken to devote to the making of other molds, and he can produce more castings with the same expenditure of energy as before. Compressed air makes it possible to obtain these results, but it must be used intelligently, and the patterns must be as nearly perfect as possible, the flasks should be specially fitted and interchangeable, there must be plenty of floor space for molding, and an abundance of sand. These improved methods were adopted by the Fort Wayne Electric Works, Fort Wayne, Ind., several years ago, resulting in a marked reduction in the cost of producing some castings, namely, from 11 cents to less than 3 cents each. When this concern built its new brass foundry not only were these modern systems retained, but other novel labor-saving features were added.

New Brass Foundry.

The new shop, recently completed by this concern, represents somewhat of a departure from established brass foundry construction, in that it is two stories high, the second story consisting of a gallery. The building, 82 x 160 feet, is of brick and steel construction, and is fireproof throughout. The steel work is heavy in proportion to the loads to be carried,

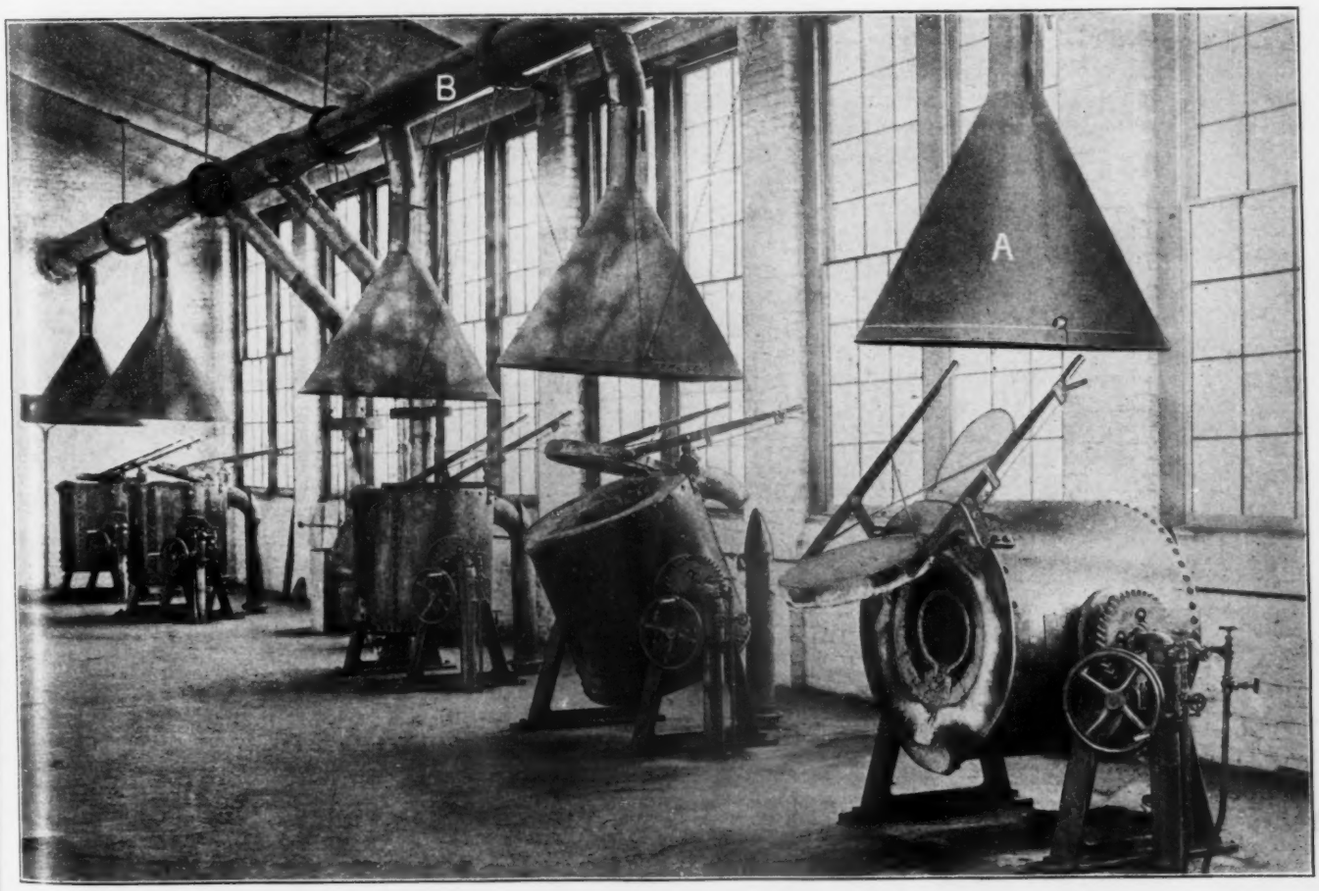


FIG. 1—VIEW OF THE MELTING DEPARTMENT, SHOWING THE OIL-FIRED TILTING FURNACES

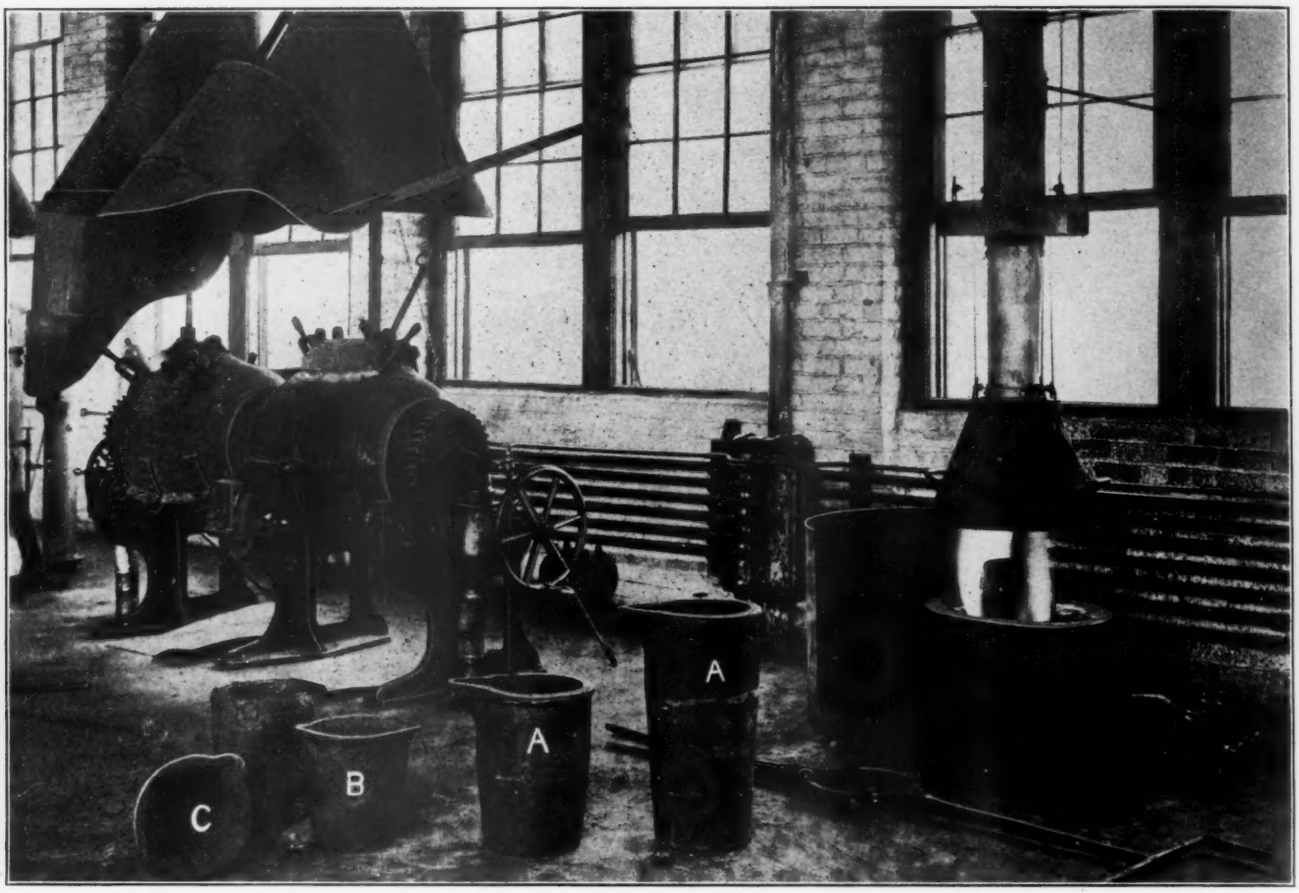


FIG. 2—DOUBLE CHAMBER MELTING FURNACE WITH THE LADLE HEATER AT THE RIGHT

and the building is arranged so as not to obstruct the carrying off of smoke and vapors. The roof and floor are of reinforced concrete, the roof being pitched considerably, so that all smoke is deflected to the monitor, which extends the entire length of the building. The monitor is equipped with swinging windows, all of which can be individually operated, so that the ventilation can be controlled according to weather conditions.

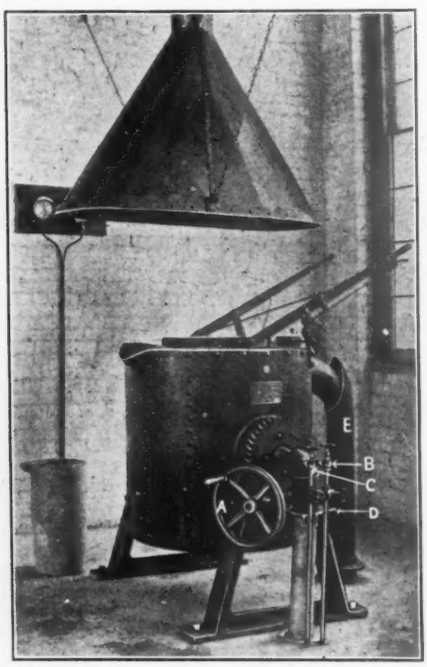


FIG. 3—ONE OF THE TILTING FURNACES IN MELTING POSITION

The Gallery.

The gallery, which constitutes the second floor, is 28 feet wide, leaving a rectangular light well in the center. This well is bridged, which makes it possible to pass quickly from one side of the gallery to the other, as shown in Fig. 5. Reinforced concrete stairs lead to the gallery at each end of the building, and an electrically-driven elevator, of 4,000 pounds capacity, is used for conveying material to the molding floor. An electric dummy hoist is provided for conveying metals from the main store room on the ground floor to the gallery store room, located immediately above. The core department, core oven and lavatory are also on the gallery floor, while on the ground floor are located the sand and metal bins, the power plant and the pattern storage room.

The gallery is fitted with its own battery of melting furnaces, and, although all the molding is done here at present, it is the intention to use this floor exclusively for aluminum in the future. The foreman's office is on the first floor, in one corner of the front end of the shop, the power plant, store room, pattern storage, etc.,

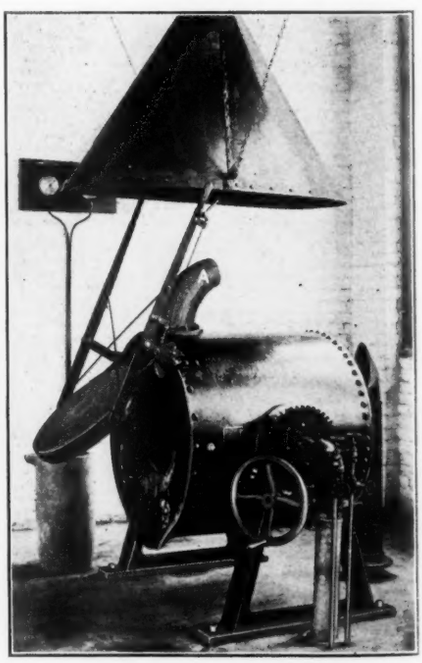


FIG. 4—MELTING FURNACE TILTED

FIG. 5—GENERAL VIEW OF THE FOUNDRY ON THE GALLERY FLOOR

being at the rear end of the building. The office is enclosed by a glass partition. The cleaning and cutting-off department is in line with the foreman's office, as shown in Fig. 9, and is equipped with a metal saw, power sprue cutters, tumbling barrel, vise bench, saw filing and saw welding machines. The sprue cutters are driven by individual motors.

A Rockwell, reverberatory scrap-melting furnace has been installed on the ground floor, which is used for melting scrap copper wire which is run into ingots, and these are again remelted for the casting metal. This furnace has a capacity of 1,500 pounds.

Sand and Metal Bins.

The sand and metal bins, in the rear of the building, are filled from hoppers opening outward to the cars on the siding. These hoppers are rectangular in shape, are made of sheet steel, hinged at the bottom, and when opened they form a chute inclined steeply to the bins. The hoppers are locked on the inside and the metal storage has no other opening except a door leading from the foundry.

Pattern Storage.

The pattern storage, Fig. 10, is equipped with metal racks and shelves, constructed of steel angles and heavy wire nettings. The position of the patterns on the upper shelves is clearly shown and the wire netting permits dust and sand to fall through the shelves onto the floor.

The building has an abundant water supply and is heated by exhaust steam, piped from the main power plant, located at a distance of several hundred feet from the foundry.

Foundry Power Plant.

The foundry is provided with its own power plant, located on the first floor. It is equipped with three individually motor-driven air compressors, and by an adjustment of the unloading device any or all of these air compressors can be operated at pressures of from 10 to 35 pounds, or from 75 to 100 pounds, as conditions may demand. Air at 100 pounds is used for squeezing, ramming, rapping, etc., and at 20 to 35 pounds for atomizing the fuel oil in the burners for the melting furnaces. It is the intention to have one compressor furnish low pressure air and one or two, as the duty demands, furnish the high pressure air. Nevertheless, reducing valves and breakdown arrangements will be provided, so that the high pressure air system can be tapped and used for the oil burners at any time. The turning of three valves and the shutting down of the low pressure air compressor are only necessary to change from low to high pressure. The air compressors are equipped with circulating pumps, and automobile radiators are employed for cooling purposes. In this manner the water consumption is reduced, the same water being used for months, only the evaporation having to be taken care of.

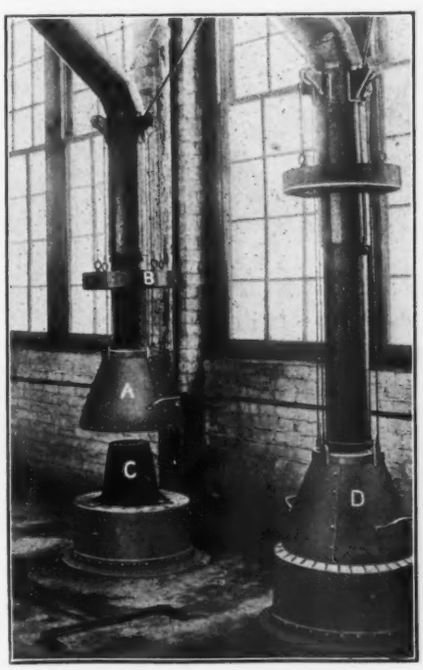


FIG. 6—THE TWO LADLE HEATERS

Blowers for Furnaces.

For furnishing the blast to the melting furnace, two high pressure blowers, supplying air at 13 ounces, and two low-pressure blowers, fur-

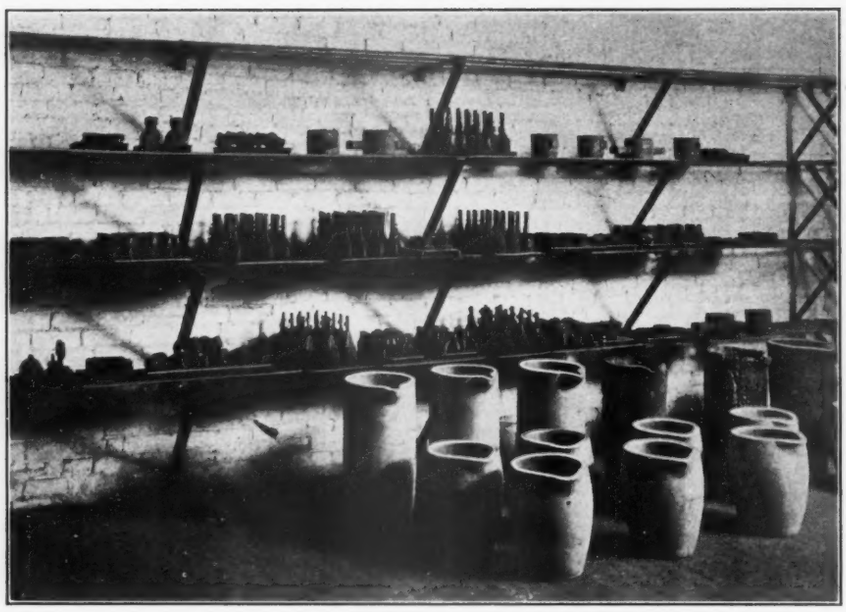


FIG. 7—INTERIOR OF THE CORE OVEN, WHERE THE CRUCIBLES ARE TEMPORARILY STORED

nishing air at 8 ounces, are provided. These are installed on the unit system, not more than three furnaces and one ladle heater constituting a unit. The scrap-melting furnace and the double chamber Rockwell furnace each have their own blower and oil-circulating pump.

Oil Pumping System.

The pumps are of the three-cylinder, slow-speed type, and have capacities of four gallons a minute. The oil is pumped by these individual pumps from two buried tanks of 6,800 gallons capacity each. The tanks are so arranged that the contents of one can be emptied into the other and either can be used independently in the event of a trial of a new grade of oil. On its way to the furnaces, the oil is passed through meters, then to automatic relief valves, which empty into a common return pipe line that leads back to the tanks. The system of metering the oil deserves special mention. It is exceedingly difficult to measure the small amount of oil that is used in melting furnaces by any of the meters now in use, and it was decided to install two meters in series for each unit, and to tap out the furnace supply lines of the individual systems from between the two meters. These meters are shown attached to the wall, in Fig. 15. All of the oil that is pumped passes through the first meter, but as some of this oil is shunted around through the burners of the furnaces and ladle heaters, the second meter registers the amount of oil pumped, minus that used by the furnaces; therefore, while from 2,000 to 2,400 gallons of oil may be pumped through each system in a day, only 80 to 100 gallons are used in the burners, and therefore the second meter will record 80 to 100 gallons less than the first, which indicates exactly the amount of fuel oil used without any chance of error. The meters can be corrected at any time by shutting off the burners and by pumping oil through the system for a certain length of time. The dials of the two meters will then indicate any discrepancy that may exist.

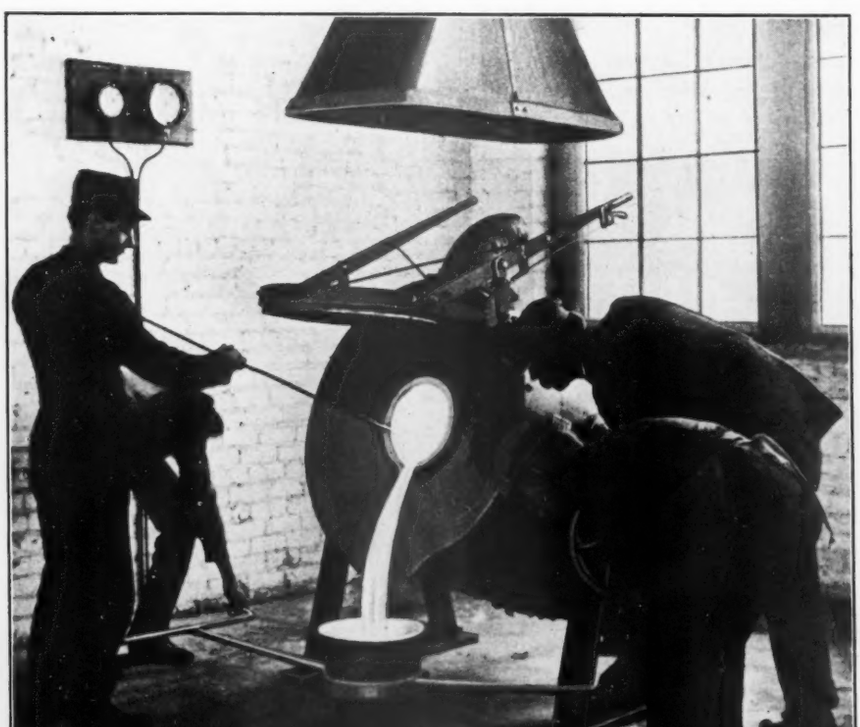


FIG. 8—TILTING FURNACE IN POURING POSITION

Air Cushions.

At the end of each burner line is installed a tank holding about a cubic foot of air, to act as a cushion or air chamber to wipe out the pump fluctuations, insuring absolutely uniform pressure. These tanks are shown attached to the wall in Fig. 15. The relief valves can be set at 25 or 35 pounds pressure, and will discharge continuously within a pound of their set rating. The oil and air pipes are located underneath the floor and are carried along the wall to the gallery, extending underneath the gallery floor. These pipes are also clearly shown in Fig. 15.

Melting Equipment.

The melting equipment on the gallery floor consists of five tilting crucible furnaces, as shown in Fig. 1, and one Rockwell, double chamber furnace of 4,000 pounds daily capacity. Three ladle heaters are also provided, one for the Rockwell and two for the five crucible furnaces. The tilting furnaces and the ladle heaters are the invention of E. A. Barnes, factory superintendent, who has devoted much time to the study of foundry engineering, and to him is also credited the excellent arrangement and design of the shop.

Tilting Furnaces.

These furnaces embody a number of novel features, including an excellent tilting arrangement, as well as the ab-

solute control of the air and oil supply by the melter while the furnace is in tilted position. The bodies are mounted on anti-friction bearings and are hung on neatly proportioned trunnions and frames. The air and oil pipes have no swing joints, but the mixture of air and oil is projected through the trunnion downward, at a tangent, into the furnace. The flame thus strikes the bottom in a swirl and is deflected upward, the gyratory effect being assisted by a spiral lining, until it strikes the cover. The flame again reverberates down, and before it can pass out of the flue it must change its direction of travel as the flue was built in at a tangent opposite to the flame rotation. The flue attached to the outside of the furnace is a curved cast iron pipe lined with carborundum sand, as shown at *A*, Fig. 4. This curved flue enters the stand pipe, *E*, Fig. 3, when the furnace is in melting position. The stand pipe connects with the main flue, which is laid in the floor, and carries the hot gases to the core oven, under the floor of which they are deflected before they enter the stack. The floor of this oven, Fig. 7, consists of diamond checkered cast iron plates laid on I beams. By means of a damper, the gases can be either partially or entirely cut off from the core oven and thrown into the stack.

Tilting Arrangement.

The furnace tilting arrangement is very simple and convenient. In place of having the hand wheel so located that the operator is at the back or side of the furnace, away from the pouring spout, the wheel is connected by direct worm gear drive at an angle, partly at the front and partly at the side, as shown at *A*, Fig. 3. This affords the furnace tender an opportunity to look into the furnace and ladle when pouring. Above each furnace is a hood, *A*, Fig. 1, which carries off the fumes when pouring, and it is suspended from a curved connection leading to the horizontal sheet iron pipe, *B*, which conveys the fumes to the chimney. Over the Rockwell furnace, Fig. 2, these hoods are fitted with visors which are let down when the furnace is rolled during the melting process, and thus carries away the fumes.

Ladle Heaters.

The Barnes ladle heaters are practically small furnaces, cut in half horizontally, the upper portion consisting of a bonnet, *A*, Fig. 6, provided with a refractory lining, and which is telescoped upward and is counterbalanced by the weight, *B*, in order to move it up and down more easily. The burner enters the lower half of the furnace at a tangent and a sufficient combustion chamber is allowed by the depth of the heater, as the ladle is set on supports several inches from the bottom, as shown at *C*, Fig. 6. The ladles are set upside down, so that the flame strikes the inside of the ladle, is deflected downward and up the outside to the chimney, and the pot, being thus enveloped by the flame, is quickly heated to a cherry red. The bonnet closed, in operating position, is shown at *D*, Fig. 6. The heaters can also be used as furnaces for melting metals in small quantities, and it is the intention of this concern to install a heater to take care of rush or small orders for special alloys. These heaters form a very valuable addition to a battery of tilting furnaces, as the cost of melting small amounts of metal is thereby greatly reduced. The burners are noiseless in operation and very efficient. The oil is thoroughly atomized and perfect combustion is attained, an oxidizing or reducing flame being produced as desired.

FIG. 9—THE CLEANING AND CUTTING-OFF DEPARTMENT

Aluminum Melting Furnaces.

The oil and air pipes under the gallery floor are steam jacketed, and the air and oil are thus heated to about 180 degrees Fahr. before reaching the burners. The double chamber Rockwell furnace is used for melting aluminum and the output at present is about 2,000

FIG. 10—PATTERN STORAGE RACKS

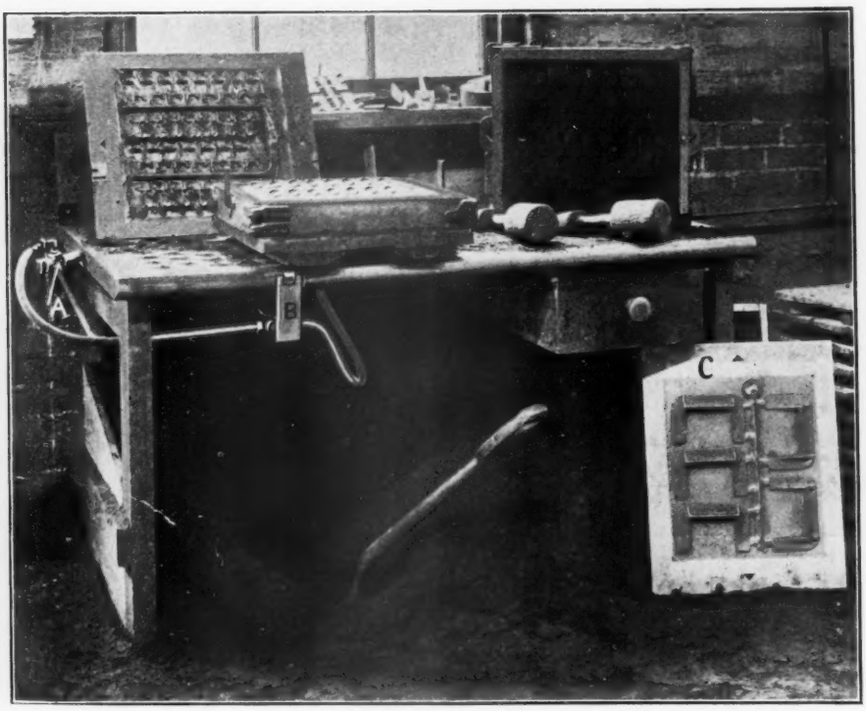


FIG. 11—ONE OF THE MOLDING BENCHES

pounds daily. The metal is carried to the mold in cast iron ladles, shown at *B*, Fig. 2, and *C*, Fig. 6. When aluminum is melted in the tilting furnaces, the cast iron crucibles, shown at *A*, Fig. 2, are used, and give excellent satisfaction when melting with oil. At *C*, Fig. 2, is shown a sheet iron ladle, lined with carborundum fire sand.

When used for aluminum, a peculiar difficulty was encountered with this carborundum-lined ladle, and the same trouble was also experienced with the Rockwell furnace, which is likewise lined with carborundum. It was found that small grains of carborundum were washed off the linings and were held in suspension by the molten aluminum, afterward being deposited in the castings. Instead of floating to the upper parts of the casting, these minute particles of carborundum remained embedded in the metal. Sometimes they were found in the gates in the path of the saw, with disastrous effects to the latter. It was some time before the source of the trouble was found, and it was remedied by glazing the linings with borax before melting the aluminum.

The proper temperature at which the aluminum should be poured was determined by a pyrometer, and was found to be from 1,350 to 1,400 degrees Fahr. This is a blood red heat, and though hotter than usual, was found necessary, as the castings are thin and the metal rises upward in the molds.

On the gallery floor are installed seven Tabor molding machines, which are equipped with air rapping devices and gages to insure accurate squeezing. Snap flasks are used exclusively for small castings, narrow cast iron bands being placed on both copes and drags, as shown at *A*, Fig. 5.

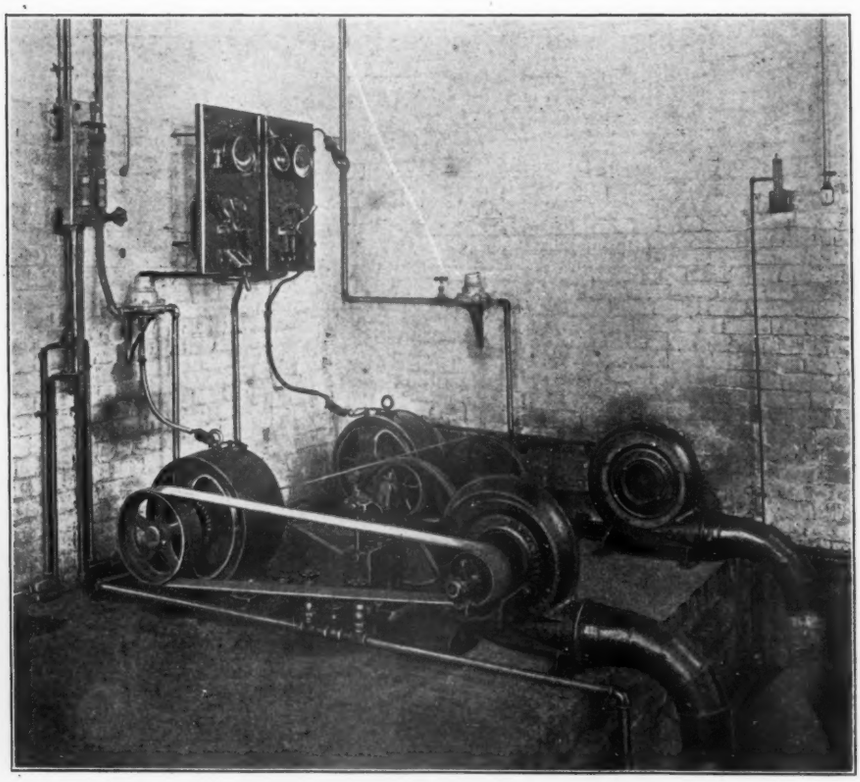


FIG. 12—VIEW OF THE POWER PLANT, SHOWING BELT-DRIVEN BLOWERS

Special Molding Tables.

The foundry is also provided with 15 special molding tables, which have now been in successful use for about eight years. These consist of strong benches, Fig. 11, about 6 feet long and 2½ feet wide. The top of the table for half its length is perforated with 2-inch holes, 1 inch apart. These openings permit the sand to fall back onto the floor, and the tables are preferred by the molders to the tubs. It is well known that the sections of a tub in contact with the sand soon rot, notably the bottom, ends and sides, which have to be renewed every three or four years when made of pine. These tables, however, give excellent service for a long period without renewals, as the sand only comes in contact with the legs, which are made of hard wood. The copes are set on that half of the table which is not perforated, and in this respect it is superior to the shovel handle laid across the ordinary tub. These tables are equipped with air vibrators, *A*, Fig. 11, that can be either attached to the table so as to jar the entire table, or in case of plate work can be adjusted to the plate and the plate alone rapped. The vibrators are operated by knee pads, *B*. One of the match-plates in use in this foundry is shown at *C*. Each bench is also supplied with a trigger-actuated air nozzle, which is used for blowing off the patterns and the bench. A drawer is also provided for the molder's tools and is equipped with a lock.

Wash Rooms.

The welfare of the molders has been carefully considered in the sanitary arrangements that have been installed.

Each employe is provided with a locker and individual wash bowls have been installed, with hot and cold running water. There are also two bath cabinets, for needle and shower baths, with a dressing room adjoining each cabinet. These cabinets are shown in Fig. 13 and another view of the lavatory is illustrated in Fig. 14.

Core Department.

The core room is well lighted, heated and ventilated. The oven for small cores is gas-fired and is located near the core department. The large core oven is in the same end of the building, in line with the furnaces, and between it and the core room is the gallery store room. No provision has been made for heating the core oven other than by the waste furnace gases. This oven is 15 x 20 feet, and while it has not yet been heated to a core baking temperature, when the main floor of the foundry is in operation it is expected that the additional furnaces will furnish all of the necessary heat. This utilization of furnace gases for baking cores is an economical arrangement that previously gave good results in the company's old foundry. The sand blast equipment is installed in another building, where the grinding, plating and polishing departments are located.

FIG. 13—VIEW OF THE LAVATORY LOOKING TOWARD THE BATH CABINETS

Semi-Steel Castings*

BY J. H. LINTON

THE name semi-steel has come to be used by the trade to signify any metal melted in the cupola which contains an admixture of steel. Some people make so-called steel by melting some small steel punchings or turnings in a ladle and then tapping hot gray iron on top of it, stirring the mixture with an iron rod, but this material is not worthy of the name, as it has but very few qualities superior to gray cast iron. It may be a little closer grained, and hence a little stronger with a steadily applied load, but that is all.

The characteristics of true semi-steel are strength, at the same time preserving softness so that it can be easily machined; elasticity, by virtue of which it resumes its original form after receiving a shock instead of breaking—in this respect it is superior to gray iron, which will break with a shock which is less than the maximum load it would stand if uniformly applied—and toughness, which makes it outwear the ordinary gray iron and makes it a good material for cylinders and all castings intended to withstand wear by friction.

The physical characteristics are well represented by the following specifications, which can readily be met by this metal: A 1 x 2 x 25-inch test bar, under transverse stress should have a shrinkage, as cast, of from 0.140 to 0.165 inch per foot. It should stand a breaking load of from 3,000 to 4,200 pounds per square inch when broken with a load applied in the center on the 2-inch side and supported on a span of 24 inches; the bar should show a deflection of from 0.35 to 0.55 inches from its original horizontal position before breaking; when cast against chill pieces, it should show shrinkage at the ends of from ⅛ to ¾ inch, according to the amount of steel in the mixture and the chemical composition of the metal. As good semi-steel can be made in a cupola with the proper selection of stock as is made by the air furnace method of melting gun iron.

Semi-steel is used exclusively in all

FIG. 14—ANOTHER VIEW OF THE LAVATORY

*Extract of an article contributed to *Power and the Factory*, Seattle.

castings and fittings in the manufacture of refrigerating machinery, as it is the only metal, aside from steel, that will withstand the pressure of the liquified ammonia gas used in the ice-making or cold storage processes. It is also used in work that requires a chilled surface, as it gives a good wearing chill. In fact, it is specified in all work requiring extra strength, elasticity and toughness, and commands from 60 to 100 per cent higher price than ordinary gray iron.

Peculiarities of Semi-Steel.

Semi-steel has its peculiarities and needs to be understood to be handled with the best success and in this respect as in many others, a little knowledge is a dangerous thing, as has been demonstrated by the experience of those who have tried mixing their irons without regard to the chemical composition. When properly handled, there is no metal easier to control or that gives as universal satisfaction as semi-steel, regardless of the verdict to the contrary by those ignorant of its good properties.

In the machine shop the metal cuts tough, but not hard. That is, the machine will have to be run at a little lower speed than it probably would on gray iron, but the tool will not dull any sooner. The finished casting will take a fine polish, being very close-grained, as the graphitic carbon is broken up into very small flakes.

Semi-steel has a characteristic dark velvety fracture, whether it contains 10 or 60 per cent steel, providing the chemical composition is correct.

Finally, on account of the superior strength of semi-steel, parts of machines can be made lighter and have the same strength, or if the original design is preferred, greater strength can be insured.

FIG. 15—STEAM JACKETED OIL AND AIR PIPES UNDER THE GALLERY FLOOR

BRASS MIXTURES FOR PLUMBERS' SUPPLIES.

BY C. VICKERS

Question:—I am about to start a brass foundry for the manufacture of plumbers' supplies, such as compression bibbs, stop cocks, globe valves and garden valves, and would like a mixture suitable for these castings. I also wish to make my mixture with scrap copper wire and turnings, using part new metal and part scrap brass.

Answer:—There are many different mixtures used on the class of castings named, and they are sometimes cast in yellow brass. We presume, however, that you desire a red metal, as you state that they are used for water pressure. The following mixtures are often used: Copper, 20 pounds; tin, 1 pound; zinc, 1 pound; lead, 1 pound.

A cheaper grade of brass follows: Copper, 20 pounds; lead, 2 pounds; zinc, 2 pounds.

Either of these mixtures can be made of scrap copper wire, and turnings, but the metal will have to be more carefully melted than if ingot copper were used; otherwise the castings will leak under pressure. If this occurs it is not the fault of the mixture but of melting, and one remedy is to use a deoxidizer. We recommend the addition of 4 ounces of 15 per cent phosphor-copper to every 100 pounds of brass.

If you want to use scrap brass in the mixture, you can do so in any proportion, as for instance, one-third scrap and two-thirds new metal, or half scrap and half new metal, etc.

SOFT GRAY IRON CASTINGS.

BY W. J. KEEP

Question:—We make a large number of gray iron hubs for agricultural implement wheels and experience some difficulty in obtaining a suitable mixture for this purpose. These hubs should be strong, and of such a composition that they will not wear out quickly. They are reamed to fit the axle and therefore must be soft enough to be easily machined.

Answer:—This is more a question of the proper amount of silicon to be used. The higher the percentage of silicon the softer the iron and the greater the wear. Reducing the silicon increases the wearing quality of the hubs, but will make them more difficult to machine. For such work, the iron should be made as hard as possible, but not so hard that it can only be machined with difficulty. An iron of this quality will be sufficiently strong. In fact for a casting of this size it will probably be stronger as the silicon increases, while with very heavy castings, the strength is reduced with an increase of silicon. To regulate the silicon you should resort to some kind of analysis, as the shrinkage varies closely with change of silicon. A measure of shrinkage is a good shop analysis.

The Berkshire Mfg. Co., Cleveland, manufacturer of molding machines, has greatly increased its manufacturing facilities. The shop has been doubled in size and is now 100 x 400 feet. A number of large tools have been installed to facilitate the machining operations and the expenditure for recent improvements and new machinery installations approximates $25,000. Sales of molding machines are reported heavy and shipments of large automatic machines are not only being made to foundries throughout the United States, but to several foreign countries as well.

THE PROPERTIES OF MOLDING SAND

Its chemical and physical requirements for green sand work as determined by investigation in England

AT THE monthly meeting of the Birmingham Branch of the British Foundrymen's Association, held at Birmingham, Eng., Saturday, March 12, J. Shaw presented a paper entitled "Molding Sand." The author dealt only with green sand suitable for gray iron work and did not attempt to cover sand for loam, cores, steel, etc. The paper is in part as follows:

Refractoriness is determined by the amount of free silica and the purity of the clay. The higher the percentage of free silica and the purer the clay, the higher the refractory power of the sand. Other things being equal, the larger the size of the grains of free silica, the greater the heat-resisting power. All other ingredients in sand, except free silica and pure clay, tend to reduce its refractory nature.

Porosity.

With porosity I have classed permeability; but, of course, there is a distinct difference. By porosity is meant the amount of pore space a sand contains in a given area; by permeability, the freedom with which a gas can travel through the same area of sand. Two sands may have equal pore space, and yet one may be less permeable than the other. The porosity of the sand determines the amount of venting necessary in a mold, and depends on the proportion of free silica to the clay, the size and shape of the free silica grains, and the condition of the clay. Generally speaking, the greater percentage of free silica, the greater the porosity of the sand, as the grains of this ingredient are comparatively large. The grains should be kept as large as is compatible with obtaining a fine skin on the casting. As free silica has no coherence, the percentage is limited by the clay needed to give the necessary bond.

According to the investigations of King, if the grains are angular and of approximately the same size, the pore space for any given size is increased, because angular particles will not pack so well. A sand containing comparatively fine grains of a uniform size will be more porous than a sand composed of coarse and fine particles.

Strength.

The strength of a sand depends, to a great extent, on the clay contents, but the purity of the clay, the shape of the free silica particles and good mixing are other factors. As already stated, the smaller the amount of clay, the more porous and refractory the sand. It therefore follows that, where possible, the quantity should be kept as low as the weight of the casting will allow. The purity of the clay is important, because it takes less to give the necessary bond, and the impurities are the ingredients that fuse easily and thereby reduce both refractoriness and porosity. Sands with grains having rough angular shapes are stronger than those with smooth surfaces, because they interlock.

That good mixing, either by hand or machine, adds considerably to the strength of a sand, is well known. Outerbridge tested this by placing test bars of sand, 6 x 1 x 1-inch, made under uniform conditions of pressure and dampness, on a smooth metal plate with sharp square edges, and by gently pushing the bars over the edge of the plate until they broke, he obtained some idea of the strength by measuring the overhang. A sand mixed and tempered by hand with a spade gave an overhang of less than 2 inches, but when riddled a dozen times, the test bars overhung about 3 inches before they broke.

Size of Grain.

The correct size of grain has been dealt with to some extent under the previous headings. A sand should be as fine as possible, to give a good skin to the casting, but the finer the sand, the more easily it is fused. Equal size grains give a porous sand, and a correct proportion of large and small grains gives a strong sand.

We have now some idea of the qualities we need in the sand for our purpose. Is it possible to formulate a set of standards with which any sand can be compared? It was with this idea that I asked several members to send a sample of the sand they were using, and at the same time to answer a number of questions as to treatment, size and shape of castings made, etc. But I must confess that owing to the personal element, sand differing in many respects gave equally good results. When a molder enters a shop, he, after a time, adapts himself to any new conditions, and by inquiry and practice overcomes difficulties in the sand, which may vary in many respects from the one he has been used to.

Analyses.

The usual tests for sands are chemical analysis, sieve test, and microscopic examination. With regard to chemical analysis, I would like to emphasize two points. Many understand that when an analysis of sand is given showing, say, 80 per cent of silica, free silica is meant, forgetting that a proportion is united with the alumina. It is for this reason I have used the term "free silica" previously. As already stated, this ingredient gives refractoriness, porosity, grain and low shrinkage to the sand, but has no bonding properties of its own.

In the same way a misunderstanding exists as regards alumina. To say a sand contains 9 per cent alumina, does not mean it has 9 per cent bond and the remaining 91 per cent free silica, as clay, or hydrated silicate of alumina, to give it its chemical name, consists of 46.4 per cent silica, 39.7 per cent alumina, and 13.9 per cent combined water, the latter giving the plastic properties to the clay. The bond of a molding sand is pure clay, but it is generally mixed with impurities which weaken its bonding power.

Clay.

Clay is formed by the decomposition of felspars. These are rocks containing silicate of alumina, together with silicates of the alkalies. After the rocks are decomposed, more or less of the alkalies are washed out by nature's agencies, the amount remaining determining the purity of the clay and hence its value as a refractory and bonding medium. The purity of the clay determines the amount necessary to give a sand its correct bonding strength. From the above it is clear that the percentage of clay should not be figured from the percentage of alumina present, as all sands contain felspars, which in turn contain alum-

ina. *This alumina in the felspar has absolutely no bonding power.*

As already stated, felspars are silicates of alumina, combined with silicates of the alkalies, and are present in all molding sands. The amount should be as low as possible, as they tend to flux the sand under moderate temperatures.

Oxide of iron is present in all molding sands, giving it its red or yellow color. It may be united with the bond as an impurity, or it may form part of the free silica. In any case, it lowers the fusing point.

Lime is generally found in molding sands; it makes the sand fusible, and the lower it is the better.

Physical Properties.

While it is generally conceded that chemical analysis of sand is of less importance than physical properties, much information may be gained if applied properly. Its use at present is to check the impurities and to see that the sand is chemically up to sample. Professor Ries points out there is no relation between the bonding power and plasticity, and the percentage of alumina present, as is generally claimed. He gives the following analyses to show this, No. 1 being a coarse grained gravelly sand, and No. 2 a fairly plastic loam:

	No. 1. Per ct.	No. 2. Per ct.	No. 3. Per ct.	No. 4. Per ct.
Silica	66.12	70.24	79.36	90 00
Alumina	16.54	16.62	9.36	4.50
Ferric oxide	4.46	3.94	3 18	1.44
Lime	0.40	0.08	0.44	0.10
Magnesia	0.22	0.09	0.27	0.10
Potash	2.67	1.41	2.19	Trace.
Soda	0.35	0.74	1.54	Trace.
Titanic oxide	0 14	0.46	0.34	0.70
Water	4.90	4.16	2.02	3.04
Moisture	4.15	2.42	0.74	....

Other examples are given in Nos. 3 and 4; No. 3 is a well-known molding sand for plate work, while No. 4 is a sandy brick clay of sufficient plasticity and cohesiveness to be used for brick manufacture. Judging from the analysis, it would be thought that No. 3 was more plastic because of its lower silica and higher alumina contents. The same author also states, that there is no relation between the chemical composition and the use to which the sand is put, and he gives a series of analyses, where sands totally different in composition are used for the same class of work.

Rational Analysis.

Whether the method advocated by Field (to whom we are indebted for much information) will give a satisfactory solution, I have not had time to test thoroughly. Certainly it offers an explanation to analyses like those just mentioned. He suggests that what is known as "rational analysis" will give a more correct idea of the constituents of a molding sand than does ultimate analysis. The former method separates the sand into three substances, quartz, clay and felspar, and he gives two examples of a sharp and strong molding sand that lend point to his theory:

SHARP MOLDING SAND.

Ultimate analyses. Per cent.		Rational analyses. Per cent.
SiO_2	80.66..Quartz substance	67.85
Al_2O_3	9.30..Clay, substance + iron oxide	22.03
Fe_2O_3	4.53..Clay, substance less iron oxide	17.50
	Felspar	10.12

STRONG MOLDING SAND.

SiO_2	77.22..Quartz substance	61.66
Al_2O_3	9.26..Clay, substance + iron oxide	28.06
Fe_2O_3	5.56..Clay, substance less iron oxide	24.50
	Felspar	7.28

Good Molding Sand.

The same author gives what he considers the ultimate analysis of a good molding sand should be:

	Per cent.
Total silica	75 to 85
Alumina	7 to 10
Lime below	2 0
Alkalies below	0.5
Iron oxide, below	6.0

The total percentage of iron oxide, lime and alkalies, or the total fluxing agencies, should not exceed 7 per cent. In high grade sand for heavy work they should not be more than 5 to 6 per cent. Mechanical analysis, or sieve testing, of sand is valuable because it gives one an idea of the texture of the sand and indirectly of the permeability and refractoriness. Unfortunately, I found no two authors following the same method of procedure.

Grain Separation.

The first to deal with grain separation, that I found, was Morse, in THE FOUNDRY, as far back as December, 1893. He simply divided his sample into coarse sand, fine sand, very fine sand, and clay.

Scott used sieves of 20, 40, 60, 80 and 100 mesh to separate his sand into different size grains. He took 10 grams of the dried sand, placed it with 10 steel balls 7/16 inches diameter, in the 100 mesh sieve and shook it with a circular motion for one minute. The sand passing through was weighed and credited to the 100 mesh sieve. The sand remaining on the sieve, together with the balls, was emptied on the 80 mesh sieve; the operation was repeated, and so on down to the 20 mesh sieve. Field's method is somewhat similar.

Professor Ries approached the problem entirely different. He took 50 grams of the sand and placed it in an 8 ounce bottle half filled with water. This mixture was put in a shaker for four hours, after which it was washed through a set of 20, 40, 60, 80 and 100 mesh sieves. The sand retained on each was dried and weighed. That which passed through the 100 mesh was caught in a jar. When all the water and suspended matter had been run through the sieves, the contents of the jar were stirred, and after standing 45 seconds the water with suspended clay and fine silt was decanted off. More water was added, the contents of the jar again stirred, and the decantation repeated. In this way two sizes were obtained. That which remained in suspension he termed the clay, and that which settled was indicated as 100 +, and most of it was retainable on a 150-mesh sieve.

Personally I tried both methods, but could not get even approximate results. With Scott's method, much depended on the condition of the dried sand, and more on the velocity and number of times the sieves were shaken. After making about 50 trials from the same kind of sand, I tried Prof. Ries' wet method. This gave far better results, but with my limited time and lack of appliances took too long to get through the samples sent.

Method Adopted.

The method adopted at last was as follows: Using 30, 60, 90 mesh sieves I added a 150 mesh sieve so as to divide the finest portion. After rolling the dried sand under a light wooden ruler, to break up the compound grains, I weighed 25 grams, placing it with 10 steel balls, 5/16 inch diameter on the 30 mesh sieve, and shook it till practically no more would go through. The portion left was credited to the 30 mesh. Placing the balls, together with the sand which had passed through the sieves in the first operation, on the 60-mesh sieve, the same routine was followed, and so on till the sample was divided into five distinct sizes of grains, each portion being weighed and credited to the size of the sieve it rested on. That which passed through the 150 sieve was called 150 +.

Coming now to the samples so kindly sent by various members, the chemical analyses of most were obtained, all submitted to the sieve test and microscopic examination.

To give a graphical idea of the differences in the samples, I obtained a number of screw-top bottles, all about

the same size. Taking five for each sample, the contents of each sieve was emptied into a bottle and the stopper marked with the mesh of the sieve and the locality of the sand. The five bottles were gummed on to a piece of cardboard, together with the answers to the questions sent. Starting in the north with samples from three prominent firms, all of whom use Erith sand; this is the finest grained sand sent in, and notwithstanding its high silica content, has a tendency to scab. I am indebted to Mr. Mayer for the following particulars: The sand is brought as ballast in boats on the return journey, and is sold in three grades. The weak top sand with least alumina, the medium quality with more alumina, and the strong, from the bottom of the pit, with most alumina, the last, of course, being used for dry sand and loam. The texture of this sand is so fine that it requires no mechanical treatment and is mixed with coal dust and in some cases a proportion of old sand, riddled and mixed ready for use.

Erith Sand.

The chemical analysis was as follows, but, of course, the alumina content will vary according to grade:

	Per cent.
SiO_2	88.25
Al_2O_3	7.70
Fe_2O_3	2.50
CaO	0.72
MgO	0.58
Loss	1.00

SIEVE TESTS.

	Weak. Per cent.	Medium. Per cent.	Strong. Per cent.
30	0.400	0.192	1.320
60	0.868	0.840	4.556
90	0.560	0.280	1.220
150	67.088	38.876	14.080
150 +	30.468	58.088	76.020
	99.384	98.275	97.196

It will be noted that the quality in 150 + increases in bulk as the alumina increases.

Lancashire Sand.

From Lancashire three samples were also received, and curiously two of these were the coarsest grained in the sands examined; but that clean fine work can be made from them anyone who has seen castings at the Lancashire and Yorkshire Railway shops can testify. In both cases the sand is well milled to give it strength. The sieve test was:

	Per cent.
30	0.800
60	41.140
90	39.056
150	13.020
150 +	4.580
	98.596

Sand From the North Midlands.

The next section came from firms in the North Midlands, from pits at Worksop (2), Mansfield (3), Kirby-in-Ashfield (1). Mr. Pilkington gave the ultimate analysis and Mr. Houghton the rational analysis of their Worksop sand:

Ultimate Analysis. Per cent.		Rational Analysis. Per cent.		Sieve test. Per cent.
SiO_2	88.00	Quartz.....	66.25	30 0.008
Al_2O_3	7.20	Clay + Fe_2O_3	12.00	60 1.280
Fe_2O_3	1.20	Clay — Fe_2O_3	10.80	90 29.308
CaO	0.20	Felspar.....	21.75	150 54.600
				150 + 14.236
				99.432

Worksop Sand.

The other sample from Worksop either was from another pit or a different strata, as the sieve test showed the sand to be considerably coarser, and it was used on heavier work without skin-drying. Mansfield also has two types of sand, a fine one for brass and light castings, and a coarser grained for heavier work. The analyses are as follows:

Ultimate analysis.	Per cent.	Sieve test.	Fine. Per cent.	Coarse. Per cent.
SiO_2.....	84.26	30	0.388	0.156
Al_2O_3.....	6.70	60	0.928	2.632
Fe_2O_3.....	3.50	90	3.388	15.128
CaO.....	0.19	150	39.160	60.932
MgO.....	0.68	150 +	54.268	19.980
			98.132	98.828

Microscopic Examination.

Coming to microscopic examination, I found most of the grains of sand with worn edges, the Erith being the most angular. Geologists tell us the sand beds from which we in the Midlands get our material once formed the bottom of a huge lake, and was deposited layer upon layer, much as the bottom of Lake Geneva is being made today, hence the rounded appearance of the grains.

While no hard and fast rules can be laid down, a knowledge of the chemical and physical properties of molding sand can but be helpful. That an artificial sand can be prepared, superior to any natural sand, and specially fitted for particular classes of work, I have proved.

BRASS VALVE MIXTURES.

Question:—Kindly give me a mixture for a good durable metal to be used for valves for a large water pump. This casting will weigh about 1½ tons and should be made of phosphor bronze.

Answer:—If you desire to use a phosphor bronze for these castings the following mixture is recommended: Copper, 85 per cent; phosphor-copper (15 per cent), 3 per cent; tin, 8 per cent, and lead, 4 per cent. It is not necessary to use phosphor bronze on such work, and if you find the above mixture too expensive, we can recommend the following: Copper, 88 per cent; tin, 5.5 per cent; zinc, 3.5 per cent; and lead, 3 per cent.

SODIUM METAL.

By C. Vickers

SODIUM metal and tin are easily alloyed. The tin is first melted at a low temperature and the sodium is added after the molten tin has been removed from the furnace. One ounce of sodium added to one pound of tin in this manner makes a brittle alloy that can be used in place of soap, and while it does not produce a lather, it readily removes dirt and grease. The surface of the metal is clouded with a white film as it runs into the ingots, the cloudy effect remaining permanent in the ingot.

It is very easily broken, but is not hard, as it can be cut with a knife. The fracture of the ingot is vertically fibrous, and the metal runs very sluggish. This alloy is difficult to cast in sand, as the sodium combines with the water in the sand and boils for a considerable period. When the castings are removed from the sand it clings to them in the form of mud, which condition the casting retains indefinitely as it continually absorbs moisture from the atmosphere.

Castings of this alloy serve no useful purpose and are not made. The experiment was carried out with a view of determining whether the alloy would cast in sand, as it appeared so sluggish when run into ingots, and the results were both interesting and curious.

Sodium tin is used for making Natrium bronze and it is usual to allow one-half ounce of sodium to one pound of tin for this purpose.

BRASS SOLDER MOLDS.

Question:—We have several brass solder molds to cast and would like to have a good mixture for the same, consisting largely of pure copper wire.

Answer:—The following mixture is recommended: Copper (ingot or wire), 88 pounds; tin, 4 pounds; zinc, 4 pounds; lead, 4 pounds.

MELTING NICKEL IN A CUPOLA.

Question:—Can you inform me why a cupola used for melting nickel will give widely varied results from day to day? We use anthracite coal almost entirely, with some coke, and find that on some days the operation of the cupola is satisfactory, while at other times, decidedly unsatisfactory results are obtained.

Answer:—The practice of melting nickel in a cupola is unusual. It seems

to us that the castings would be high in carbon and would therefore be brittle. However, if these castings suit your purpose we would suggest that you make a careful study of the manner in which the cupola is charged and operated, keeping a daily record for a comparison of the satisfactory and unsatisfactory operations of the furnace. It will be necessary for you to note every detail, including the weighing of the fuel and charges, and a careful record should be maintained of the condition of the bed to ascertain whether it is permitted to become hotter on some days than on others before charging the nickel. We believe that you will find the trouble is caused by variations in charging and operation, which you will be gradually able to correct.

Composition Match-Plates

THE match-plate, frequently styled the original molding machine, has been a potent factor in the reduction of hand molding costs in foundries where it is in use. Originally made of sand or plaster, it is now produced of metal, aluminum preferred, for duplicate work in large quantities. Some of the alloys of this white metal have the strength of cast iron and in addition are much lighter in weight. When used only on the bench, the match-plate enables the molder to greatly increase his output, and its combination with either a hand or power-ramming machine is an ideal arrangement, that further facilitates production.

Sand and plaster matches, well-known to every foundryman, satisfactorily serve the purpose for which they are intended, but neither is durable, plaster matches especially being brittle and easily broken. When making metal match-plates, the shrinkage problem is an ever-present difficulty, and regardless of the process by which the plates are made, it is customary to reproduce the wood pattern in white metal, from which the match-plate mold is made.

FIG. 2—EXCEEDINGLY CROOKED CASTING, PATTERN OF WHICH IS MOUNTED ON MATCH-PLATE, FIGS. 1 AND 4

Composition Match-Plates.

The Bayer Pattern Plate & Mfg. Co., Poe avenue and West Twenty-fifth street, Cleveland, is manufacturing match-plates from a special composition, which possesses all of the advantages of metals generally used for this purpose, without any of their undesirable features. The composition does not shrink and the match-plates are exact reproductions of the patterns. Micrometer measurements of many of the plates thus far produced have shown them to conform exactly to the original wood or metal pattern in size. This composition is lighter than iron and white metal and will withstand rapping and vibrating. The surface of these plates is absolutely smooth and the composition will not sweat, regardless of atmospheric conditions, nor is it affected by ordinary temperatures. The composition is furthermore of such a nature that it can be soldered with the same material, which obviates the necessity of discarding the plate when a section of the pattern is broken off. The composition likewise insures sharp definition of edges and corners, and for this reason is desirable for the reproduction of ornamental patterns.

The drag half of a composition match-plate containing the pattern of an exceedingly crooked casting, Fig. 2, and a draft door of a stove, is shown in Fig. 1. The mounting of this crooked pattern on a match-plate entailed careful work in obtaining the parting, and this section, thus mounted, enabled the molder to greatly increase his daily output. The cope half of this plate is shown in Fig. 4. Figs. 5 and 6 are the drag and cope plates of six tees on one gate. Split patterns were provided, four of these being metal and two wood. The original patterns were mounted on the plate as shown, and this was accomplished by fastening pins in the patterns, around which the composition

FIG. 1—DRAG HALF OF A COMPOSITION MATCH-PLATE SHOWING THE PATTERN OF THE CROOKED CASTING, FIG. 2, AT THE BOTTOM OF THE PLATE

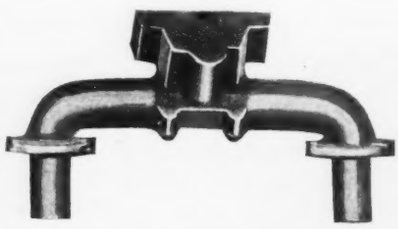


FIG. 3—PATTERN OF A CURVED FLANGED PIPE ON MATCH-PLATES, FIGS. 8 AND 10

FIG. 4—COPE HALF OF THE MATCH-PLATE, DRAG OF WHICH IS SHOWN IN FIG. 1

was poured, thus securely fastening the pattern to the plate. These are sample plates as the prints extend onto the frames. Fig. 3 is a wood pattern of an aluminum pipe for an automobile motor. The pattern was not split and was reproduced on the match-plates shown in Figs. 8 and 10. Owing to the intricate construction of the pattern, which prevented a draw in the drag, two loose pieces had to be provided in the drag, which are shown on one corner of the plate, Fig. 8. These loose pieces formed a part of the match-plate and are indicative of the possibilities of this material for match-plate work. A mold made from the drag plate is shown in Fig. 7, and the cope half of the mold, made from the cope plate, Fig. 10, is illustrated in Fig. 9. Cope and drag halves of a composition match-plate, containing the pattern of a flanged pipe are shown in Figs 11 and 12.

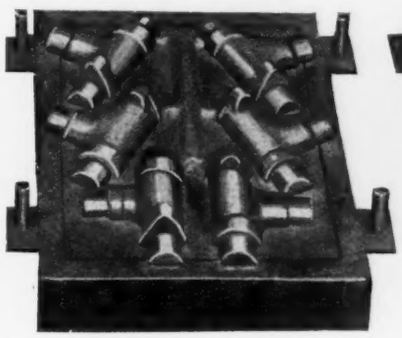


FIG. 5—DRAG HALF OF COMPOSITION PLATE ON WHICH SPLIT PATTERNS OF SIX TEES ARE MOUNTED

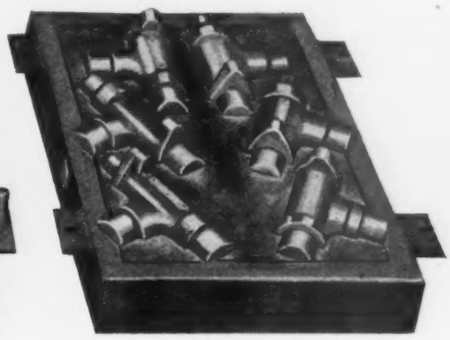


FIG. 6—COPE HALF OF MATCH-PLATE, DRAG OF WHICH IS SHOWN IN FIG. 5

Making Composition Match-Plates.

When making match-plates of this composition, whole or split patterns can be used advantageously, and these are molded in sand, care being exercised to obtain an accurate parting. After the cope and drag halves of the mold have been made, the cope and drag match-plate frames are set on these molds and a careful adjustment is made of the flask pins and flask pin openings. The match-plate frames are provided with wood bottoms with openings through which the composition is poured. The material is heated and is poured into the sand mold in a molten condition. The composition possesses the property of flowing into the smallest crevice and in addition sharply outlines all edges and corners. After a period of about 12 hours the match-plate is ready for use. The Bayer Pattern Plate & Mfg. Co. is engaged in the manufacture of these match-plates for the foundry trade, but does not offer the composition for sale.

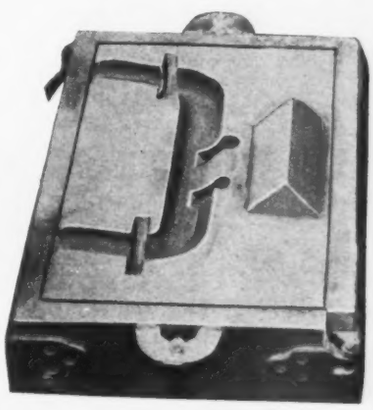


FIG. 9—COPE HALF OF MOLD MADE FROM MATCH-PLATE, FIG. 10

FIG. 10—COMPOSITION MATCH-PLATE FROM WHICH COPE HALF OF MOLD, FIG. 9, WAS MADE

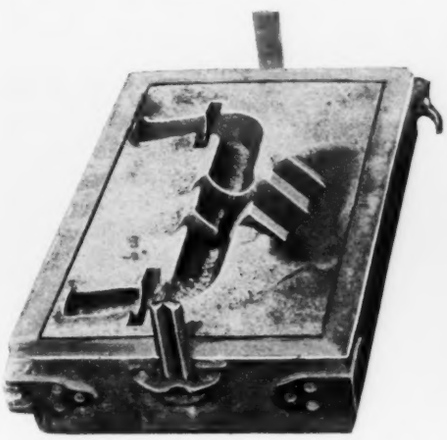


FIG. 7—DRAG HALF OF THE MOLD MADE ON THE MATCH-PLATE, FIG. 8

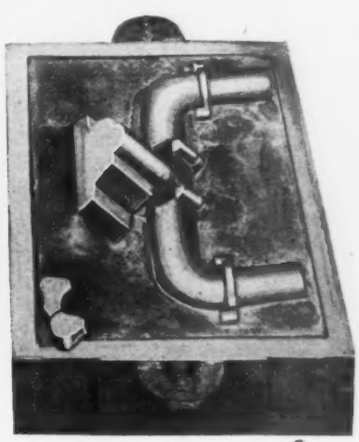


FIG. 8—DRAG HALF OF COMPOSITION MATCH-PLATE, SHOWING LOOSE PIECES ON ONE CORNER

THE SHRINKAGE OF ALUMINUM.

Question:—What material can we mix with aluminum to prevent shrink holes in heavy lugs cast onto light castings? We are using 33 1/3 per cent zinc and 66 2/3 per cent aluminum in our mixture and the shrinkage is the same as that of pure aluminum.

Answer:—There is no material that can be added to aluminum alloys to prevent shrinkage and would suggest the use of chills on the heavy lugs if they cannot be fed with risers. An alloy of aluminum, 93 per cent, and copper, 7 per cent, does not shrink as much as the aluminum mixture you are using and might be better for your purpose.

SILICA SAND.

Silica sand, or silicic acid, exists in great quantities all over the world. Common quartz and flint, as well as rock crystal, agate and similar substances, are pure silicic acid. The yellow sand of sea beaches and of many sterile tracts of land are silicic acid contaminated with oxide of iron, etc. It is this yellow silica sand that is used largely in facing molds for

steel castings, not because it is better than the white sand but merely cheaper. The purer the silica sand the higher its fusion point and the more colorless it is. Pennsylvania is noted for its high quality of silica sand. After mining it is ground, cleaned and graded and some samples analyze 98 to 99 per cent silica.

The fusion point of yellow silica sand is much lower than that of white sand, as the metallic oxides exert a fluxing action on the silica and form a glass. This yellow sand is satisfactory as a facing for steel work, although the better grades are generally used for furnace bottoms.

Clay is a hydrated silicate of alumina, the refractory clays being called fire clay. The most refractory of these contains an excess of alumina. The poorer varieties contain basic oxides, which exert a fluxing action on the alumina, making it more easily fusible. The fire clay used in steel facing should be high grade, otherwise it will fuse into the castings and defeat the purpose of the facing. It is only used to give plasticity to the sand, and in this it is aided by molasses.

Silica flour is quartz rock ground to an impalpable powder. This is more infusible than the facing, as it is purer.

Silica flour is mixed with molasses water and painted or sprayed onto the mold, thereby closing the pores and thus imparts a smooth surface to the casting.

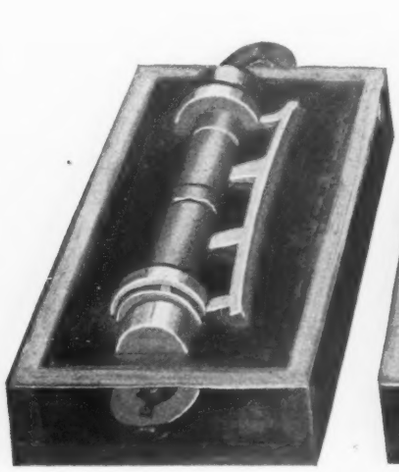


FIG. 11—COPE MATCH-PLATE OF A FLANGED PIPE

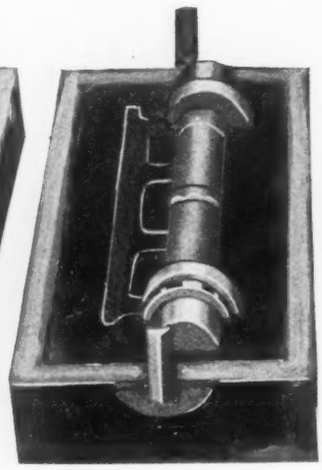


FIG. 12—DRAG MATCH-PLATE OF A FLANGED PIPE

The Chemist in the Brass Foundry*

BY W. M. CORSE

THE statement has recently been made that the twentieth century is going to be the era of the chemical engineer, as the nineteenth was that of the mechanical engineer. One has but to look about him to see evidences of this development to realize the truth of this statement. More and more of our manufacturers are coming to see that the underlying principles of their processes are chemical and that a knowledge of these principles is essential to the proper conduct of their business, if it is to be operated at a profit. The brass manufacturer has begun to realize this condition, and the number of testing laboratories that have been installed in connection with this industry, are proof of this fact.

*Presented at the March meeting of the Chicago section of the American Chemical Society.

Experiences in Brass Foundries.

I have had the good fortune to install four chemical laboratories, three of which have been in connection with brass foundries. A short history of their development may be of interest. The first was established because of the trouble the manufacturer was having with the metal. The oxidation of the metal was high, and the composition of the mixture was varied to such an extent that very bad results were obtained from the castings when they were subjected to hydraulic pressure. My first work was to ascertain the amount of oxidation and volatilization, in order to maintain the composition of the resulting alloy uniform. Numerous tests were made and it was found that 35 per cent more zinc was lost than was allowed for. It was also found that all the remelt was put into one general pile and as this amounted to 50 per cent of the melt, the indiscriminate use of this remelt changed the formula very materially. One thing led to another, until finally all formulas for metal were made up in the laboratory and the resulting melts were analized regularly to see if these formulas gave the desired result. This all may seem very simple, and undoubtedly is, but the fact is that the majority of brass founders are in ignorance of just these principles of their daily operation. The last seven years have witnessed remarkable strides along such lines as described, so that some founders now know considerably more about metallurgy than they did before the chemist was employed.

Many times I have been asked the question, "Of what use is a chemist in a brass foundry?" This question was asked by men actually operating foundries. Today the number of analyses made is probably 500 times as many as five years ago. Although the manufacturer may not have come to the point of using the chemist, he is generally willing to concede his value.

Analyses of Raw Materials.

From testing the furnace products for formula, I worked to examining the raw materials for purity. These include copper, tin, lead, zinc, ingot brass, scrap brass and sometimes antimony. Aluminum also comes in prominently for some kinds of work and has to be tested. The majority of aluminum casting makers buy their alloys ready made as it were, so that less work is done on their component parts than on finished alloys.

Reducing the Cost of Alloys.

The cost of an alloy is, of course, determined by the cost of its component parts, and when these vary quite widely in price, a variation in composition sometimes means the difference between profit and loss. For instance, copper costs now about 14 cents per pound and zinc and lead average 5 cents per pound. An alloy figured for 70 per cent copper, but actually carrying 72 per cent will cost 18 cents a hundred pounds more than it should. On a weekly melt of 100,000 pounds this means $180 a week, or $9,360 a year. This is by no means an unusual instance, and goes to show what a very small saving per pound may mean. It also shows how the exact control of a formula may save money for the manu-

facturer. It is safe to assert that over a thousand pairs of metals have never been alloyed, and many times this number of combinations of three or more metals have never even been thought of. The surface of this enormous field has scarcely been scratched and offers as much promise for investigation as any that I know.

If any industry needs the attention of the technical man, it is the foundry business. Rule-of-thumb methods predominate and opportunities for investigation lie at every hand.

Refractories.

In addition to the metallurgy, we have the various refractory materials and their connection with furnace design and upkeep. They comprise such products as fire brick, fire clay, fire sand and carborundum. The various molding sands also come in for attention. These should be tested for fineness, binding qualities, resistance to hot metal, porosity, etc. Core sands are tested for fineness and refractory qualities. Crucibles are an important item of expense and should be tested regularly to insure maintaining uniform quality.

Coke can be tested for ash and sulphur, although a practical test for burning qualities is generally the most important. If oil is used for fuel, it also comes into the laboratory for test.

Tests of Refuse.

All brass foundries have copper bearing refuse of various kinds, which cannot be worked up satisfactorily with the equipment generally available. In order to sell these for anything like their proper value, it is necessary to know either their metallic contents, or their copper contents, which again makes work for the chemist. As a general thing, experimental work cannot be properly taken care of by the foreman. The nature of his duties prevents him from giving concentrated attention to any problem for any great length of time, inasmuch as continued interruptions render impossible the proper recording of his observations. The chemist is therefore the logical man to conduct this kind of work.

Work of the Chemist.

It usually happens that the chemist is the only technical man around the foundry, so that it properly falls to his lot to record the results of all tests made, whether they are chemical, physical or practical tests of material. He often can be of help in devising production records, loss reports and summaries of such data as pounds produced per man per day, fuel consumed per 100 pounds of metal melted and others too numerous to mention. He can do the planning for engineering work such as is commonly required in a foundry and can aid in the solving of such engineering problems as may arise.

Realization of the Chemist's Value.

I think I have made it sufficiently clear how a chemist can be used to advantage in any brass foundry large enough to warrant the outlay for a laboratory. For smaller foundries the commercial testing laboratory is available and does very satisfactory work along some lines. Experience has shown that many foundries would employ their own metallurgist, as the brass foundry chemist may properly be called, could they but realize the many uses to which his services could be put. In my position as secretary of the American Brass Founders' Association, I have had exceptional opportunities to watch the development of the brass foundry laboratory and I have observed that the manufacturers, who are making the highest quality goods in a business like manner, are foremost in utilizing this department. Could the practical foundryman be made to realize that a technical man makes his own position more valuable and by co-operation vastly increases his own usefulness, a great step forward would be taken in this ancient and intensely interesting industry.

COPPER SOLUTION FOR SMALL CASTINGS.

Question:—Kindly furnish us a solution for plating small castings.

Answer:—Clean the castings by pickling in dilute sulphuric acid in the proportions of 1 of acid to 20 of water, and then immerse the castings in a solution of 8 ounces of sulphate of copper, 4 ounces of sulphuric acid, and 5 gallons of water. You can also tumble the castings for a few minutes in sawdust moistened with this solution. The castings are then washed in hot water and dried in sawdust.

USE OF ALUMINUM AS A DEOXIDIZER IN BRASS.

Question:—Our chandelier castings develop a great many blow-holes after they are polished. How can this be prevented?

Answer:—One concern in the west uses a small percentage of aluminum as a deoxidizer in its chandelier castings. The aluminum must not be in sufficient quantity to show on the castings, and as it is difficult to introduce such a small portion direct, it must be done in the form of an alloy, in the proportions of one ounce of aluminum to one pound of zinc. Two ounces of this alloy will introduce ⅛ ounce of aluminum. This is sufficient for 100 pounds of metal. A little experimental work will determine the proper quantity, as the aluminum must no more than faintly show on the edges and raised lines of the castings. In addition to this, careful melting is advised. K. K.

BOOK REVIEWS.

Metal Statistics.—Published by the Metal Market Co., 81 Fulton street, New York City, 3½ x 6 inches, 176 pages.

The 1910 edition of this work embraces several new features. The iron and steel section has been revised and enlarged by B. E. V. Luty of Pittsburg, who enjoys a wide acquaintance in the steel trade and is best known for his statistical compilations bearing on this industry. Price fluctuations of the non-ferrous metals, as well as the annual production of copper, tin, lead, spelter, etc., covering a period of years, are also included.

Pattern Making.—By G. H. Willard, 5 x 7 inches, 224 pages, 312 illustrations, published by the Popular Mechanics Co. and furnished by the Penton Publishing Co.; price $1.

This work explains the elementary principles of pattermaking, describes the tools used, the various woods, forms of joints, and outlines the art of turning, the use of circular saws, and carries the reader from the manufacture of the simpler forms of patterns to those that are more complex. The book is divided into two parts, the first, containing 24 chapters, being devoted to patternmaking, and the second, three chapters, by F. D. Crawshaw, treats of coremaking and molding.

URANIUMITE.

A new flux intended for brass foundry use, known by the trade name of "Uraniumite," is now being manufactured by the Buffalo Uraniumite Co. It is claimed that this flux does not interfere with the metal combinations or the chemical contents, and that tests in actual practice have proven that it imparts greater tensile strength and elongation to the metal, making it close-grained, and greatly reduces loss from blow-holes. It thereby permits the use of an all-scrap mixture and in addition reduces the cost of machining castings in which this flux has been used. This flux produces these results by combining with and burning off the gases, and by carrying the dirt and impurities to the surface of the metal, depositing them in the slag. "Uraniumite" is used in the form of a metallic powder, chemically treated, and is manufactured for use in both the ferrous and non-ferrous metals.

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Trade Outlook

Notwithstanding the recent heavy sales of pig iron, quotations during the closing week of March continue to decline and it is evident that the market is largely in buyers' hands. Production continues heavy and the movement of iron from furnace yards is unabated, stocks showing no increase. Bessemer iron is quoted on the basis of $18.40, Pittsburg, equivalent to $17.50, valley furnace; No. 2 foundry iron is held at $16.00 to $16.25, valley furnace, $18.00, Philadelphia, and No. 2 southern is quoted at $16.25, Cincinnati. In the south, $13.00 is the basis for No. 2, and it is believed that this quotation could be shaded on a desirable tonnage. In the east, basic iron is slightly lower and is quoted at $18.00, eastern Pennsylvania, and $16.00 at Shenango and Mahoning valley furnaces. The entire pig iron market has declined approximately 50 cents during the past 30 days, and despite the recent heavy buying movement, producers show no inclination to advance prices. Gray iron foundries, without exception, are operating at capacity, and their melt is large. The heavy requirements of the railroads crowd the steel foundries to the limit, and the implement makers are taking a round tonnage of malleables. The automobile industry continues to draw heavily upon the brass and aluminum foundries, and to meet the heavy requirements of this trade many new shops are being built for the production of castings from the non-ferrous metals. The prices of new metals remain practically unchanged and are approximately as follows: Lake copper, New York, 13.75 cents; electrolytic copper, New York, 13.37½ cents; spelter, St. Louis, 5.58 cents; lead, St. Louis, 4.30 cents; tin, New York, 32.35 cents; antimony, New York, 8.25 cents; nickel, New York, 45 cents.

Malleable Iron Annealing Pots

The cost of annealing pots in malleable foundries is an expense burden which must be carefully considered when computing the cost of the finished product. While castings are annealed in steel foundries, the cost of the operation does not compare with that of the malleable shop, and the duration of the anneal is much shorter. Although many attempts have been made to eliminate the annealing pot, by far the great majority of malleable foundries in the United States still adhere to this method, yet in several large works the castings are piled into the open furnace and packed in scale, no pots being used. The supporters of this method claim that the time of the anneal is reduced and that the quality of the product compares favorably with that annealed in pots. On the other hand, many foundrymen, who have experimented with the open method of charging, have returned to the use of the pots, claiming that pot-annealed castings are superior in quality to those charged openly in the furnace. In the majority of foundries the pots are cast of furnace iron, although many use cupola iron for this purpose. It is customary to mold the pots on the floor, no cope being used, although in several plants, pots weighing 400 pounds or more, are molded in a two-part flask. The pots vary in weight in proportion to the size and weight of the product, the smaller pots averaging 100 pounds, while the largest, approximately 500 pounds. For general work, 250 to 300 pounds seems to be the average in American shops. In many foundries the regular melt of furnace iron is used for pots, although the cost of the mixture can be reduced materially if a special heat is run for these molds. A high percentage of malleable scrap can be charged, some foundrymen using as high as 70 per cent, the remainder being pig metal. One special furnace mixture recommended, in which the percentage of malleable scrap is very low, follows: Malleable scrap, 35 per cent; cast scrap, 35 per cent; pig iron, 30 per cent. Cupola mixtures vary considerably, some foundries using as much as 90 per cent of malleable scrap, although the average is not over 70 per cent. In practically all of the mixtures, varying percentages of malleable Bessemer and No. 2 foundry iron are used. The use of cast steel pots is an innovation in malleable foundry practice, which has been productive of good results in several foundries where the experiments have been conducted. The life of these pots is nearly double the average of those made of furnace and cupola iron, but against this must be charged their greatly increased cost. The number of heats that can be obtained from annealing pots will vary according to the temperature of the furnace and the time of the anneal. In some foundries, records as high as 28 heats have been established with pots made of furnace iron, and again similar boxes may have been discarded after eight or nine heats. A fair average for furnace iron pots is approximately 13 heats, while those made of cupola iron show slightly better results, al-

though probably not sufficient to warrant the special operation of a cupola for this purpose. Reports of experiments with steel pots are encouraging to the malleable founder, as they show a minimum of about 20 heats and as high as 25 heats. A series of interesting annealing furnace tests, recently conducted, to ascertain the relative value of lump coal and screenings showed results favorable to the former, although against this must be charged the increased cost of this grade of fuel as compared with screenings. One furnace, under fire 109 hours, burning screenings, showed a fuel consumption of 1 pound of coal to 1.75 pounds of castings. Another test with screenings, 108 hours duration, showed a fuel consumption of 1 pound of coal to 1.4 pounds of castings. Using lump coal and with the furnaces under fire 100, 110 and 115 hours, the results were respectively as follows: One pound of coal to 2.12 pounds of castings; 1 pound of coal to 1.6 pounds of castings, and 1 pound of coal to 2.3 pounds of castings. Tests, to ascertain the amount of coal required to melt iron in malleable furnaces, showed an average of approximately 2 pounds of iron to 1 pound of coal, the period covering the time when the firing of the cold furnace began to the end of the second heat. When three heats are made in one furnace per day, the coal consumption would naturally be reduced, as the fuel required for heating the furnace for the first heat would be spread over three, instead of two heats.

North Pacific Foundry Trade

Improvement continues to characterize the foundry trade of the Pacific northwest, although the progress made during the past month is not as great as would have been achieved had weather and traffic conditions been more favorable. The prospect of heavy buying by the lumber and logging interests this spring is keeping the manufacturing plants busy, and in marine lines the number of vessels under construction for the coasting trade is greater by 100 per cent than during the spring of 1909. Considerable municipal work has been let, including ornamental cluster lamp posts and cast iron pipe. Foundries in Seattle and Portland have secured good tonnages of lamp posts, but the great majority of the cast iron pipe orders have gone to eastern and Alabama pipe works. Building work has been moderate in volume, but a number of large projects are now pending in Seattle and Portland.

PERSONAL.

Charles Vickers, during the past five years superintendent of the brass foundry of the Milwaukee Electric Railway & Light Co., Milwaukee, has resigned to accept the position of associate editor of THE FOUNDRY. He is unusually well qualified for his new line of work, having been a prolific contributor on brass foundry subjects to technical publications during the past 15 years. Before leaving Milwaukee, Mr. Vickers was presented with a handsome watch fob by his associates.

George Davies has been appointed New York representative of the Lehigh Foundry Co., Fullerton, Pa., and will have offices at 50 Church street, New York City.

John M. Perkins, superintendent of the foundry of the Lowell Machine Shop, Lowell, Mass., has resigned to take charge of one of the new foundries of the Detroit Stoker & Foundry Co., Detroit. Previous to his connection with the Lowell Machine Shop, Mr. Perkins was superintendent of the foundry of the U. S. Steel Co., Everett, Mass.

Dr. Richard Moldenke, secretary of the American Foundrymen's Association, recently returned from a professional trip to Europe. At Berlin he attended a meeting of the foundrymen and foundry foremen of northern Germany, and delivered an address on American foundry practice.

Edwin H. Johnson is now associated with the Montford Machine Casting Co., 90 West street, New York City, and is representing this concern in New York and vicinity.

John A. Rathbone, inventor of the Rathbone multiple molding machine, is now associated with the American Oxhydric Co., Milwaukee, in the capacity of general manager.

Harry Hoover, a foundry foreman of wide experience, has accepted a position as salesman with the S. Obermayer Co., Cincinnati, manufacturers of foundry facings, supplies and equipment, and will represent this concern in Buffalo and Dunkirk, N. Y.

James Savage, foreman of the brass and aluminum foundries of the F. I. A. T. Automobile Co., Poughkeepsie, N. Y., has resigned and is now a member of the firm of Savage & Lee, which operates a foundry at 233 Java street, Brooklyn, N. Y.

L. G. Delamothe, inventor of the method of metallizing flowers, is now located at Santa Rosa, Cal., where he has established a studio and will metallize the Luther Burbank fruits and flowers.

Harry O. Price, formerly associated with Walter-Wallingford & Co., Pittsburg, is now one of the partners of the firm of C. H. Lewis & Co., pig iron and coke merchants, of Cleveland and Pittsburg. Mr. Price will have charge of the Pittsburg territory, with an office in the Oliver building.

W. A. Ten Winkle, for the past six years advertising manager of the Electric Controller & Supply Co., Cleveland, has accepted the position of special advertising representative of THE FOUNDRY, *The Iron Trade Review* and other publications of the Penton Publishing Co.

Walter B. Snow, publicity engineer, 170 Summer street, Boston, announces that Benjamin Baker, late editor of *The Navy*, and Herbert M. Wilcox, chemical engineer, have been added to his staff.

Walter M. McFarland, associated with the Westinghouse Electric & Mfg. Co., Pittsburg, since 1899, has resigned to accept a position in an official capacity with the Babcock & Wilcox Co., New York City.

OBITUARY.

James Duncan, superintendent of the Builders' Iron Foundry, Providence, R. I., died March 21. Born in Glasgow 44 years ago, he served as an apprentice in Pollock Shaws, near Glasgow, and worked as a journeyman in the MacKenzie and Allison jobbing foundries in Glasgow. Mr. Duncan came to America when about 21 years of age, and first secured employment in Pittsburg and later in the Colvin Foundry, Providence. He afterward secured employment with the Builders' Iron Foundry as a journeyman molder, and about eight years ago was appointed foreman, and later foundry superintendent. While thus employed, he supervised the production of some of the largest steam turbine castings used by the navy department. His widow and six children survive him.

Richard Coulter Oliphant, president of the Trenton Malleable Iron Works, Trenton, N. J., died March 4, aged 57 years. He was born Sept. 6, 1852, in Uniontown, Pa., and after his public school course and a partial course at Princeton University, Mr. Oliphant engaged in the insurance business at Chicago. Later he returned to Uniontown, Pa., and was connected with his father and brother in the operation of a blast furnace. In 1881, he engaged in pottery manufacture at Trenton, N. J., and on the absorption of the plant by the Trenton Potteries Co., he became connected with the Trenton Malleable Iron Co. and was president and general manager until his death. For a number of years he was prominent in the National Founders' Association and was a member of the administrative council in 1905 and 1906.

MODERN EQUIPMENT FOR THE FOUNDRY

Combination squeezer and roll-over molding machine --- Centrifugal air compressor --- Buffing and grinding outfit --- Sash operating device --- Chaplets for small and large cores

A COMBINATION squeezer and roll-over molding machine, which can also be used as an ordinary squeezer, without the roll-over device, is shown in the accompanying illustrations. The machine is portable, being mounted on four wheels, and is well constructed throughout. It is made the proper height for molding without compelling the operator to unnecessarily bend over while making the mold. The roll-over table, on which the pattern plates or match-plates are mounted, swings on a shaft supported by the two cast iron side frames, as shown in Fig. 1. The table is slotted to permit of bolting on plates of various sizes.

The entire mold is made in one operation when work of snap flask size is being produced, but on larger patterns, within the capacity of the machine, only copes or drags are made when the plates are too large to permit of bolting both cope and drag plates to the table. The cast iron presser head is supported by two steel rods, which operate on shafts attached to the lower ends of the side frames. The squeezing of the molds is accomplished by a compound lever movement, actuated by the hand lever at the side. The presser plate is adjustable to molds of various heights, this being accomplished by the nuts on each of the steel rods operating the presser head. The machine, with cope and drag match-plates bolted to the table, is shown in Fig. 1. When making a mold the flasks are set over the plates and after filling them with sand and adjusting the cope and bottom boards, the head is swung forward and the mold is rammed by the movement of the hand lever, as shown in Fig. 2. Throughout this ramming operation the table is held in position by a pin at the side, which is withdrawn when the table with the molds is to be rolled over. Before this is done, however, the molds are clamped with forks extending through the table at either end, both halves of the mold being clamped with one movement.

After the molds are rolled over, Fig. 3, a table, counterbalanced by two springs to facilitate its upward movement, is raised by a lever which actuates gears on either side that engage the racks supporting the table. The clamps are then removed and the table on which the cope and drag halves of the mold are now resting is lowered, thereby withdrawing the patterns from the cope and drag halves of the molds.

With the added weight of the molds, the table is practically lowered by gravity, thus eliminating another movement on the part of the operator. Fig. 4 shows the table lowered with the patterns drawn. The table has been moved forward, sliding in two guides, well protected from the sand with steel shields. The molds are then in position to permit the operator to remove the snap flasks, and the mold closed, ready to be placed on the floor, is shown in Fig. 5. After the mold has been carried off, the lower table is pushed back, the upper table, carrying the match-plate, is rolled over in position for making another mold, as shown in Fig. 5. When used as a squeezer only the upper table, carrying the match-plates, remains in a fixed position, being held by a pin at the side. This combination squeezer and roll-over molding machine is built by the Bayer Pattern Plate & Mfg. Co., Poe avenue and West Twenty-fifth street, Cleveland.

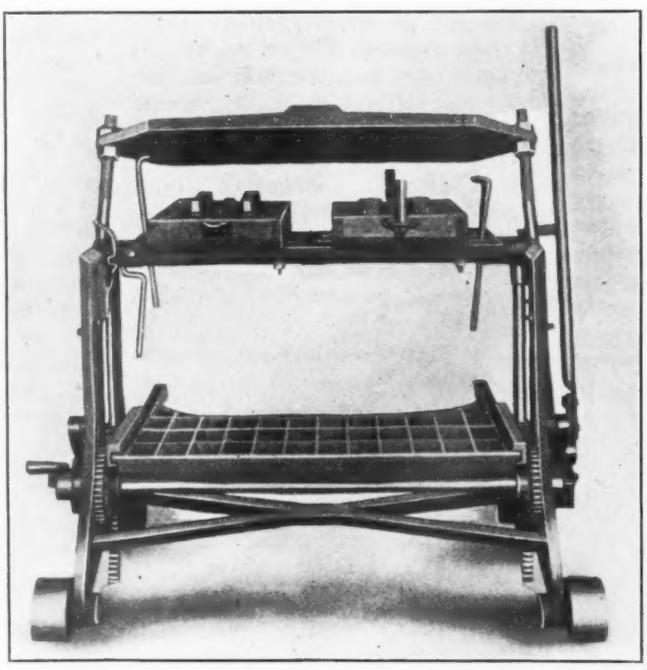


FIG. 1—COMBINATION SQUEEZER AND ROLL-OVER MOLDING MACHINE

HIGH GRADE SILICA SAND.

The United States Silica Co., 1044 American Trust building, Chicago, operates one of the largest plants in the United States for the production of washed silica sand. The nature of this company's deposit and the completeness of its equipment enables it to produce a material practically chemically pure, which is sold under a guaranteed analysis of 99.89 per cent silica. Owing to its large storage capacity this concern is in position to make shipments at any time during the year. This material is adapted for use in sand blasting, as a core wash in steel foundries, for cores for iron and steel work and in mixtures for the enamel of cast iron enameled ware.

The Modern Systems Correspondence Schools, 6 Beacon street, Boston, Mass., in a 12-page circular recently issued, describe their method of instruction by mail. The course comprises modern manufacturing cost systems, shop organization and management, mechanical engineering, mechanical drawing, modern pattern shop and foundry systems, etc. The school is under the direction of Oscar E. Perrigo, whose varied experience as a practical shop man, factory manager and consulting engineer peculiarly fit him for this work. He is the author of many articles and several well known books on shop practice, factory management, cost systems, etc.

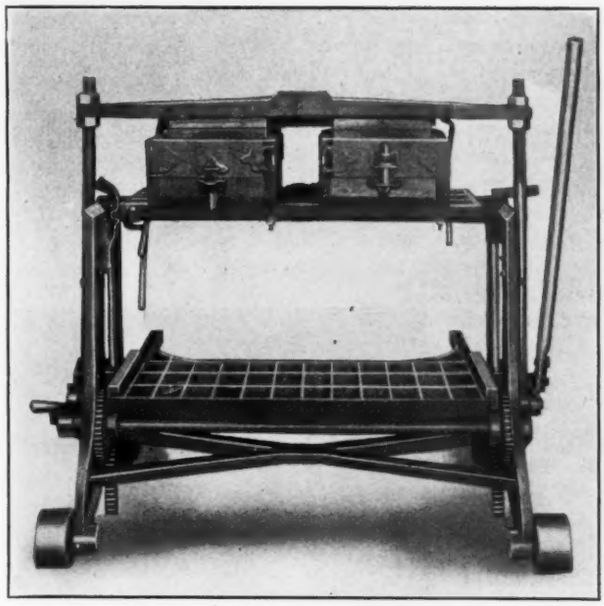


FIG. 2—COMBINATION MOLDING MACHINE IN RAMMING POSITION

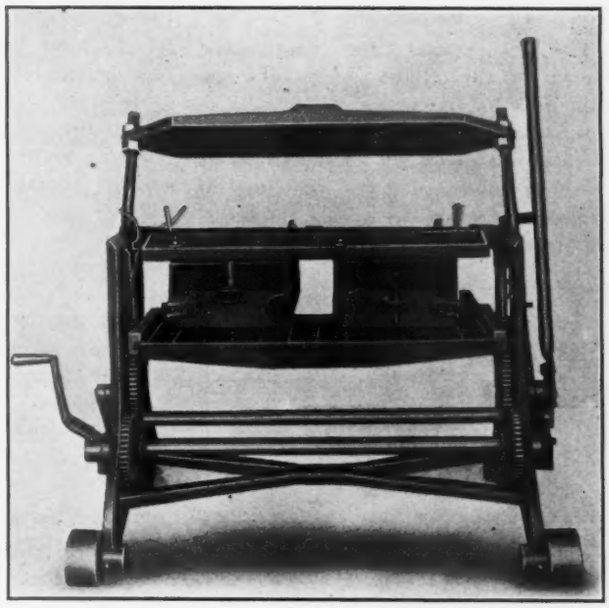


FIG. 3—FLASKS ROLLED OVER AND DEPOSITED ON THE TABLE BEFORE LOWERING THE MOLDS AWAY FROM THE PATTERNS

VENTLESS FOUNDRY FACING.

As a result of a large amount of experimental work, the Federal Foundry Supply Co., Cleveland and Milwaukee, has succeeded in perfecting a ventless foundry facing which is high in volatile matter, low in ash and very low in sulphur. The analysis of this ventless facing follows:

	Per cent.
Moisture	0.43
Volatile matter	51.18
Fixed carbon	45.17
Ash	3.22
Sulphur	1.31

The analysis of another high grade sea coal is given below and it will be noted that the ventless facing contains 1.05 per cent less moisture, is 15.6 per cent higher in volatile matter, contains 3.78 per cent less ash, and is 0.10 per cent lower in sulphur:

	Per cent.
Moisture	1.48
Volatile matter	35.58
Fixed carbon	55.94
Ash	7.00
Sulphur	1.41

The volatile matter in this ventless facing, amounting to 51.18 per cent, takes precedence over the fixed carbon, which is exactly the reverse of the regular facing. It is claimed by the makers that this product is more economical to use than ordinary or high grades of sea coal facing. On heavy work it is the customary practice to use facing in the approximate proportions of 1 to 8, whereas the ratio of ventless facing is 1 to 24. For light work, ordinary facing is used in the proportion of 1 to 10 and 1 to 12, as against 1 to 30 and 1 to 36 of the ventless facing.

It is also guaranteed to eliminate 50 per cent of the work required in venting molds, thereby effecting a considerable saving of the molder's time. This, however, is not considered in estimating the economy in the use of this facing, which is based on its use in quantities two-thirds less than ordinary facings. The price of this facing is twice that of the ordinary grades, owing to the expensive process of manufacture, but notwithstanding this fact, the saving effected by its use is estimated at 33-1/3 per cent.

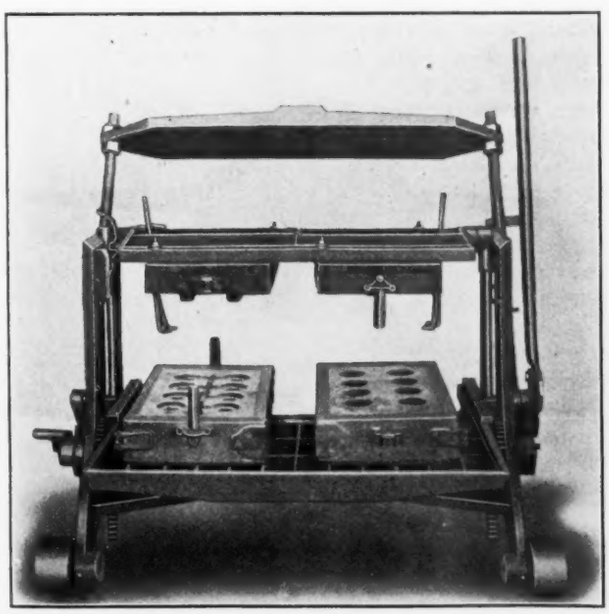


FIG. 4—TABLE LOWERED, WITH THE PATTERNS WITHDRAWN FROM THE COPE AND DRAG HALVES OF THE MOLD

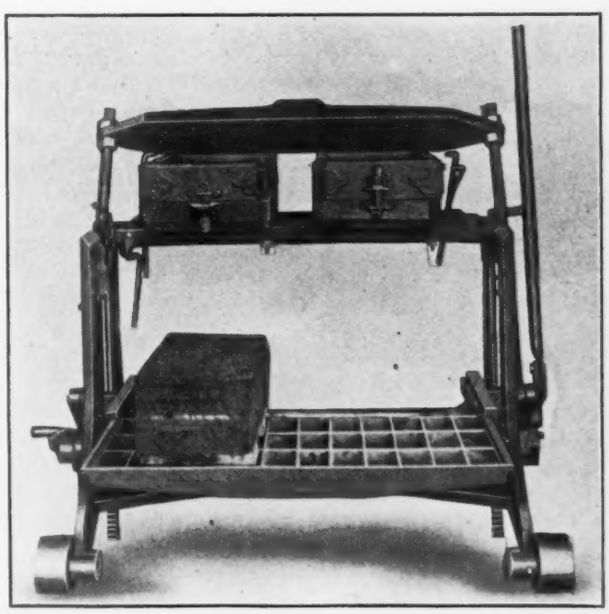
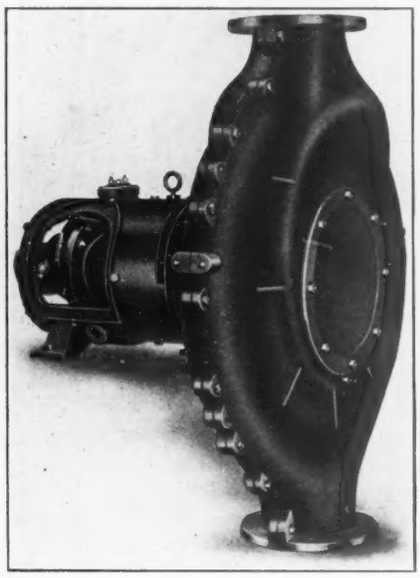


FIG. 5—LOWER TABLE PULLED OUT, THE MOLD CLOSED, AND THE MATCH-PLATES ARE AGAIN IN RAMMING POSITION

A CENTRIFUGAL AIR COMPRESSOR.

The centrifugal air compressor, shown in the accompanying illustration, built by the General Electric Co., Schenectady, N. Y., is especially adapted for use with oil burners. This concern builds a standard line of single and multi-stage centrifugal compressors, in capacities from 5 to



CENTRIFUGAL AIR COMPRESSOR

350 horsepower, the single stage being designed for pressures of 1 to 4 pounds per square inch and the multi-stage, adapted for use with oil burners, is designed for pressures from 15 to 30 pounds per square inch. Fuel oil is now being extensively used for baking cores and for melting iron, steel and non-ferrous metals, as well as for lighting cupolas, skin drying molds, drying cores, etc.

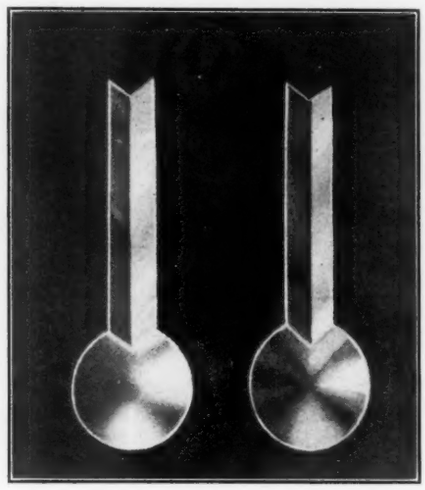
These compressor sets are self-contained and are direct-driven by Curtis steam turbines or direct current motors. They have no wearing or rubbing parts and for this reason there is no reduction in pressure or output due to leakage, regardless of the length of time of operation. The pressure is steady and free from pulsations, which is important, as the oil must be intimately mixed with the air to properly burn in a reasonable space without smoke. In the burner, the oil is reduced to very small drops which must be surrounded by air, this being termed atomization. The drops must be very small, inasmuch as one of any appreciable size, even though surrounded by the entire amount necessary for its combustion, will be projected for a considerable distance from the burner in the form of a small ball of yellow flame before it is completely consumed. Compressed air is used in melting furnaces for atomization, and the atomized air must be mixed with additional air to insure perfect combustion. This is sometimes accomplished by the air being entrained or sucked in by the velocity of the jet issuing from the burner, and sometimes by forced draft from a fan blower delivering the air through a pipe ending under the burner, at a comparatively low velocity. All of these conditions have been carefully considered in the design of this new air compressor.

ALTERNATING CURRENT BUFFING AND GRINDING OUTFIT.

An alternating current buffing and grinding outfit of an improved type is being manufactured by the General Electric Co., Schenectady, N. Y., which is designed for use in foundries, pattern shops, wood-working establishments, machine shops, etc. This outfit, Fig. 1, consists of an alternating current motor on a substantial base, fitted with a tool rest and water attachment, rigidly clamped to the bearing brackets, to permit of easy removal when desired. The motor is rendered splash and dust proof, being entirely inclosed, and each end of the shaft is fitted with two steel flanges, two leather washers and a nut for clamping the abrasive wheel. The shafts, bearings and all working parts are made extra strong and durable, to withstand hard and constant usage.

The buffing outfit, Fig. 2, is self-contained, and its use effects a considerable saving of time and labor. This device is similar in construction to the grinding equipment, with the exception of the omission of the tool and water attachments. The shaft is longer, each end being tapered and threaded to receive the buffs. The bearing brackets are circular, and are designed to admit of being turned through 90 degrees, for side wall installation.

The following grinding and polishing outfits are made by the General Electric Co. for operation on single, two or three phase, 110-220 volt circuits: The capacities, single phase, include ⅜, 1, 2 and 3 horsepower, and polyphase, ⅜, 1, 2, 3, 5 and 7½ horsepower. Neither abrasive wheels nor buffs are furnished with this equipment.



SPOON CHAPLETS

SPOON CHAPLETS.

Spoon chaplets or anchors, shown in the accompanying illustration, manufactured by Burdick & Son, Albany, N. Y., have been especially designed to facilitate the setting of cores in molds. These anchors are rammed in position in the cores when made, the cup end fitting into an impression in the mold, thereby permitting of the immediate location of the core in its proper position. These chaplets, which are heavily tinned, and are made in two sizes, have given excellent satisfaction on gas stove and small work, and their use reduces the number of broken and patched molds to the minimum, thereby increasing the molder's daily output. Cores in which these chaplets were used were illustrated in the March issue of THE FOUNDRY, pages 7 and 9.

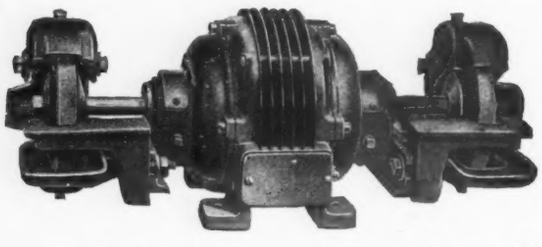


FIG. 1—ALTERNATING CURRENT GRINDING OUTFIT

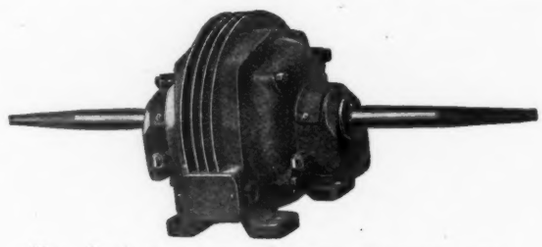


FIG. 2—ALTERNATING CURRENT BUFFING AND POLISHING OUTFIT

SASH OPERATING DEVICE.

The G. Drouve Co., Bridgeport, Conn., is manufacturing a new device for operating hinged sashes. It is designed to operate under varying conditions without getting out of order, an essential feature of sash devices for factories, which are subjected to rough usage, as the windows are frequently pried open with crow bars when the sash swells and sticks in damp weather.

This sash operator pushes the sash outward by means of two ½-inch steel rods operating by leverage, one arm being attached to each side of the sash at the lower part of the side rail, thus opening the window. These two arms are adjustable for 30 and 45 degree openings. The main levers on each

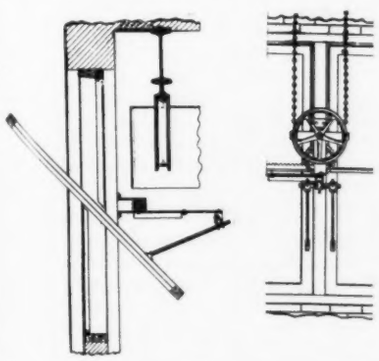


FIG. 2—SECTIONAL ELEVATION OF SASH OPEN AND FRONT VIEW OF SASH OPERATING DEVICE

sash are fastened to a line of ¾-inch pipe shaft with an open coupling, which moves backward and forward between spool roller brackets secured at each interval between windows, a rack and pinion with a geared wheel controlled by a chain from the floor giving the forward and return movement. A guide lever is attached at the top of each bracket and in turn is fastened to the main lever. The unattached end of the main lever has a U-shaped chair pivoted to it which operates the shaft connecting the two steel arms, while the shaft operates freely in the U-shaped chair support, permitting the arm to follow the inclination of the shaft. The backward and forward movements of the main shaft operate the levers at each window and as all the arms are moved simultaneously, the arms being directed straight at each side of the sash, the windows are opened or closed as desired. This appliance is designed to operate pivoted side, pivoted top and bottom sash, as well as sash hinged at the top or bottom. The connections are phosphor bronze to iron, thus preventing the operating parts from rusting together. Fig. 1 shows plan views of this device with the sash opened and closed, and Fig. 2 shows a sectional view of the sash open, as well as a front view of this device.

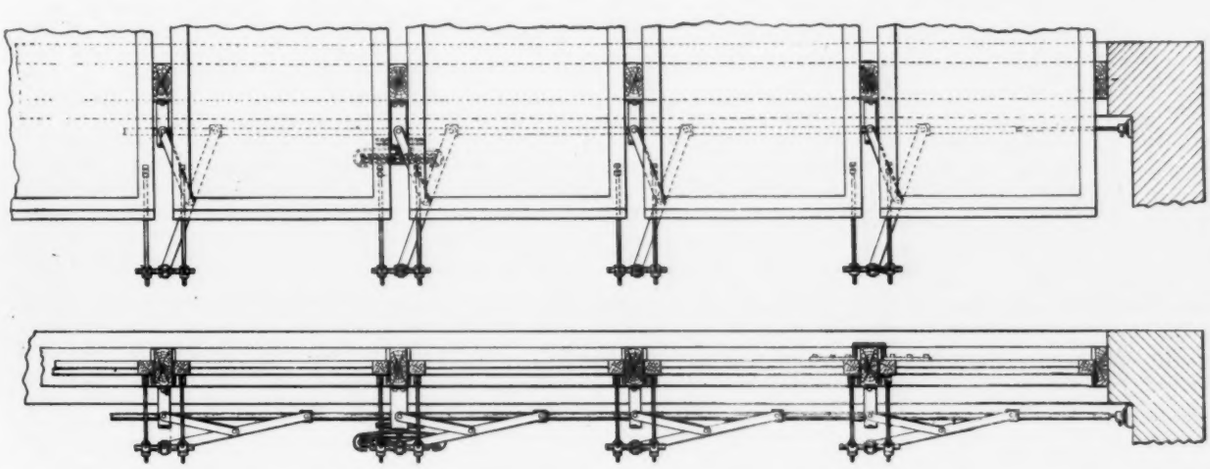


FIG. 1—PLAN VIEWS SHOWING SASH OPEN AND CLOSED

The J. D. Smith Foundry Supply Co., Cleveland, continues to receive large orders for core ovens. Among the contracts recently closed are the following: Core ovens, brass and aluminum furnaces for the Packard Motor Car Co., Detroit; core oven for the E. M. F. Co., Detroit; two core ovens for the Lozier Motor Car Co., Plattsburg, N. Y.; four core ovens for the A. B. C. Castings Co., Cleveland; one core oven for the Michigan Motor Casting Co., Detroit; one core oven and other brass foundry equipment for the F. I. A. T. Co., Pougkeepsie, N. Y.; one aluminum and one coke-fired brass furnace for the Standard Brass Foundry Co., Cleveland, and a core oven and aluminum furnace for the National Bronze & Aluminum Foundry Co., Cleveland.

EDWARD PRIDMORE.

Edward Pridmore, Batavia, N. Y., who was connected with the Johnston Harvester Co., of that city, for many years, died March 4 at an advanced age. He was the father of the late Henry E. Pridmore, of Chicago, manufacturer of molding machines, and also of John Pridmore, head of the experimental department of the International Harvester Co. In the development of the harvesting machine the members of the Pridmore family have held a very high position as inventors, designers and mechanical experts.

CHAPLETS FOR HEAVY CORES.

The accompanying illustrations show a special chaplet designed for supporting heavy cores where the pressure on the plates is unusually great. The sectional view shows the supporting plate which

REINFORCED CHAPLETS FOR LARGE CORES

reinforces the top and bottom plates and prevents them from bending or slipping down over the stem. This protection is essential, especially on large work, where there is danger of a chaplet collapsing under heavy strains. These chaplets are made in various sizes by the Philadelphia Chaplet & Mfg. Co., Philadelphia.

C. Drucklieb, 178 Washington street, New York City, announces that he has disposed of his interest in the injector sand blast apparatus which he has manufactured, to James M. Betton, who has had the practical management of this branch of Mr. Drucklieb's business for the past five years. The sand blast business will be carried on as heretofore under the name of J. M. Betton, with offices at 178 Washington street, New York City.

TRADE NOTES.

The Vanadium Sales Co. of America, Frick building, Pittsburg, has published catalogs, in French and German, describing the use of vanadium in steel. Many illustrations are included of vanadium steel sections and the results of many tests are given.

The Detroit Foundry Supply Co., Detroit, has been appointed exclusive selling agents for the roll-over molding machines manufactured by the Midland Machine Co., of the same city.

The Shanafelt Mfg. Co., Canton, O., manufacturer of foundry and pattern shop supplies, is sending to the trade a four-page pamphlet describing fibre brushes for hot glueing. These fibres are firmly bound in tin with brass nails, thereby preventing rust and the subsequent loosening of the fibres. The handles are made of a special quality of wood, to withstand pot use, and are double-coated with shellac. These brushes are made in 12 sizes, from ⅜ inch to 2 inches in width, ¼ to ¾ inch in thickness, and fibre lengths from ¾ inch to 2 inches.

At the convention of the American Foundrymen's Association to be held in Detroit, June 6 to 11, the Adams Co., Dubuque, Ia., will exhibit three new molding machines, including a Farwell pneumatic roll-over, a 24-inch squeezer equipped with an improved type of table, and a new Farwell squeezer, designed for use with the Keep hinged match-plate device.

The office of the Interstate Sand Co. has been removed from 907 Garfield building, Cleveland, to the Masonic Temple, Zanesville, O.

The Domhoff & Joyce Co., Cincinnati, dealer in pig iron and coke, has opened a branch office at 1331 Schofield building, Cleveland, R. D. Jenkins being resident manager.

The Hanna Engineering Works, Chicago, reports extensive sales of the Rathbone multiple molding machine. The second order has been received from the Vulcan Plow Co., Evansville, Ind., and a repeat order for two machines from the Green Engineering Co., Chicago. A machine will also be installed in the plant of the Lynchburg Foundry Co., Lynchburg, Va. The sales of the Hanna shaker average one per day.

The Turner Brass Works, Sycamore, Ill., is now manufacturing the line of blow torches formerly made by the Acorn Brass Mfg. Co., Chicago.

The American Compressor & Pump Co., New York City, has established its general sales offices at 718 East Pratt street, Baltimore. The New York office of this concern is located in the Hudson Terminal, 30 Church street.

The firm name of the Cutter, Wood & Stevens Co., Boston, has been changed to the Cutter & Wood Supply Co. and the capital stock has been increased owing to the recent growth of the business of this concern. The foundry supply and equipment department has been greatly extended as well as the metal polishing and platers' supplies lines. In addition this concern carries a large stock of machinists' and patternmakers' supplies and equipment.

The tramrail department of the J. W. Paxson Co., Philadelphia, has closed contracts for the Moyer tramrail equipment for the entire plant of the McNab & Harlin Mfg. Co., Paterson, N. J., E. E. Brown & Co.'s new sash weight Foundry, Philadelphia, National Car Wheel Co., Pittsburg, and for the new plant of this concern, which is being erected at Cleveland.

The MacFarland-Snyder Co., dealers in polishers' and platers' material, grinding and polishing machinery, mill and factory supplies, has removed from 1022 St. Clair avenue N. E. to larger quarters at 803 St. Clair avenue.

The Robins Conveying Belt Co. announces the removal of its executive offices, as well as the engineering and purchasing departments, to the 26th and 27th floors and both towers of the Park Row building, 13 Park Row, New York City. The office at 30 Church street will be discontinued, and will be combined with the other offices of the company in the Park Row building.

Robert Kamm, consulting engineer to the Raritan Copper Works, Perth Amboy, N. J., has established a commercial laboratory at 24 Cliff street, New York city.

The W. D. Allen Mfg. Co., Chicago, in a 112-page catalog, describes its extensive line of brass goods, which consists of sprinklers, couplings and nozzles of all kinds as well as grease cups, shaft oilers, etc.

The Ohio Blower Co., Cleveland, has purchased a site of two and one-half acres, accessible to both the Erie and Pennsylvania railroads, on which a new plant will be erected during the year. This concern builds dust collecting systems and installs heating and ventilating apparatus in factories and other large buildings.

TRADE PUBLICATIONS.

FUEL OIL BURNERS.—The W. S. Rockwell Co., New York City, in a 32-page illustrated catalog describes its extensive line of furnaces and burners heated with fuel oil and gas. This concern manufactures positive pressure blowers, oil pumping and storage systems, pressure tanks, oil and gas fired furnaces, etc. Illustrations are given of several different burners designed to meet the varying requirements of high and low pressure air. Steam-actuated and belt-driven pumping systems are described in detail and a sectional view is contained in this catalog showing the necessary appliances and the method of delivering and burning fuel oil as well as its conveyance from the tank cars to the furnaces. Capacity tables of fuel oil are also included and these are followed by a supplement containing much valuable data on the heat values of liquid fuel, as well as the melting points, specific gravities and weights of metals.

STEAM TURBINES.—The B. F. Sturtevant Co., Hyde Park, Mass., in bulletin No. 176, illustrates and describes the Sturtevant steam turbine. These turbines are built with standard discs 10, 15, 20, 25, 30 and 36 inches in diameter, and by suitably combining the size of the disc, rotative speed, nozzle capacity and steam pressure, a range of from 1 to 150 horsepower can be covered by the unit best adapted to the work. High speed blowers used in foundries, direct-coupled to turbines of from 5 to 10 horsepower, operate at 1,800 to 3,600 revolutions per minute.

LIFTING MAGNETS.—The Cutler-Hammer Clutch Co., Milwaukee, in a 12-page folder, illustrates and describes its line of lifting magnets. A cross-sectional view of one of these magnets is included, which shows the entire construction of this device.

AIR COMPRESSORS.—The National Brake & Electric Co., Milwaukee, in a 36-page catalog, describes its line of motor-driven air compressors. These are designed for pressures of from 60 to 100 pounds per square inch, but can be furnished for pressures up to 150 pounds per square inch at a slightly reduced capacity rating. The driving power is transmitted from the motors to the compressors by means of a herring-bone pinion and gear.

HEATING AND ANNEALING FURNACES.—The Rockwell Furnace Co., 50 Church street, New York City, in catalog No. 8, containing 16 pages, describes its line of furnaces designed for forging, flanging, plate heating, angle bending, spring fitting, case hardening, tempering, annealing, etc. These furnaces can be fired with either oil or gas. A circular has also been issued by this concern describing the barium chloride and cylindrical hardening furnaces. The barium chloride process eliminates the danger of the old method of hardening steel, as the barium chloride forms a thin coating on the surface of the steel and protects it from the air while it is being transferred to the quenching bath.

MOLDING MACHINES.—The Adams Co., Dubuque, Ia., in a 16-page circular, bound in a loose leaf binder, illustrates and describes Farwell squeezers and universal molding machines, Adams grinders, cherry snap flasks and fittings. The Farwell squeezer is built in various widths for different classes of work and its method of operation with metal plates and patterns, otherwise mounted, is shown. The universal molding machines made by this concern are suitable for stripping plate work and possess all of the desirable features of Farwell squeezers when using match-plates or carded patterns. These machines are adapted for any work beyond the range of the squeezers. The snap flasks are made in various sizes and shapes to meet casting requirements and illustrations of molds with the flasks cut for irregular partings are given. Three different types of grinders are illustrated, a special feature being made of the rubber cushion bearing.

TUMBLING MILLS.—The Cleveland Nickel Works, Cleveland, is sending to the trade a 36-page, illustrated catalog, describing its extensive line of steel exhaust tumbling

mills, water tumbling mills, cinder mills, dust arrestors and hard iron stars used for tumbling castings. This concern also makes mills for cleaning and planishing stove plate and hollow ware, for cleaning soil pipe with enlarged or flanged ends, as well as mills for general foundry work and for polishing small castings that are to be plated. These mills have recently been improved in many ways, and as now constructed they require only a relatively small amount of power to operate being equipped with self-oiling bearings. All parts are interchangeable, facilitating repairs. The hard iron stars are recommended, as the manufacturer claims that the object of milling castings is not only to remove sand but to smooth and planish the surfaces.

FOUNDRY MACHINERY AND EQUIPMENT.—The Northern Engineering Works, Detroit, in booklet No. 93, containing 24 pages, illustrates and briefly describes its line of equipment for the foundry trade. The booklet is merely intended as a reminder of the extensive line of foundry machinery made by the Northern Engineering Works, and additional particulars of all of the equipment shown are contained in larger catalogs and bulletins referred to in this booklet.

GENERAL INDUSTRIAL NOTES

The plant of the New Milford Foundry & Machine Co., New Milford, Conn., which was destroyed by fire recently, will be rebuilt.

The plant of the Harold Foundry & Machine Co., New Kensington, Pa., has been acquired by the Pittsburg Sanitary Mfg. Co., Pittsburg, and will be converted into a foundry for the production of cast iron enameled sanitary ware.

The Perry Steel Co., Buffalo, has been incorporated with $100,000 capital, to engage in the manufacture of steel castings by the converter process. G. W. Perry, of Philadelphia, is president.

The Machine-Molded Brass Casting Co. has established a plant at 285 South street, Boston, for the manufacture of brass castings.

The Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa., is building a yard crane runway, 40 x 200 feet, for handling flasks and raw materials.

J. W. Conway, formerly with the Standard Foundry, Hartford, Conn., has equipped a brass foundry in that city at 424-432 Broad street.

The Enterprise Foundry & Fence Co., Indianapolis, will lease its present foundry and machine shop upon the completion of its new plant. The foundry of these works will be 65 x 150 feet.

The plant of the Bausch Machine Tool Co., Springfield, Mass., has been purchased by the National Equipment Co., the holding corporation of the Confectioners' Machinery & Mfg. Co., Springfield, Mass.

The Sanitary Co. of America, recently incorporated, which absorbed the plant of the Mitchell & Van Meter Co., Philadelphia, has acquired another plant at Thirteenth and Cumberland streets, that city.

The firm name of the Evansville Brass & Iron Bed Mfg. Co., Evansville, Ind., has been changed to the Evansville Metal Bed Co. The capital stock has been increased from $60,000 to $100,000.

The National Roll & Foundry Co., Pittsburg, will add a 50-ton open-hearth furnace for the manufacture of steel castings.

The Standard Brass Foundry Co., Salt Lake City, Utah, has been organized with $6,000 capital to take over the foundry operated by A. M. Perkins and A. B. Duckworth.

The plant of the Vincennes Pipe & Casting Co., Vincennes, Ind., was recently sold at receiver's sale to Louis A. Meyer.

C. Norsworthy & Co., St. Thomas, Ont., will engage in the manufacture of furnaces and radiators, having taken over the Howard Furnace plant, Berlin, Ont.

The Globe Malleable Iron & Steel Co., Syracuse, N. Y., is the outgrowth of the Globe Malleable Iron Co., the change in the name being necessary for future developments in the manufacture of steel products by this concern. Plans are now being prepared for the erection of a large drop forge plant.

The Zanesville Malleable Co., Zanesville, O., is adding another air furnace.

The Ornamental Iron & Bronze Co., Cleveland, has established a plant at 10611 Quincy avenue for the manufacture of ornamental iron and brass work.

The Provo Foundry & Machine Co., Provo, Utah, has been organized to take over the foundry and machine shop operated by Thomas F. Pierpont. The company is capitalized at $50,000.

J. M. Dodd, Buchanan, Va., has recently completed a foundry having 800 square feet of floor space, which will be operated under the name of the Buchanan Foundry Co.

The Longmount Foundry & Machine Co., Longmount, Colo., is operating a foundry, 30 x 50 feet, equipped for the production of both brass and iron castings.

The Cartga Foundry Co., Rome, Ga., has been organized with $20,000 capital to engage in the manufacture of stoves.

The foundry formerly operated by W. P. Ford & Co., Concord, N. H., which was founded by Wm. P. Ford in 1836, recently passed into new hands and will be known as the Ford Foundry Co. John W. Storrs is president, Albert I. Foster treasurer and business manager, and Edward D. Storrs, superintendent.

The Standard Foundry Co., Lansing, Mich., has been organized with $20,000 capital to engage in the manufacture of pumps. The company will occupy the plant of the Hildreth Mfg. Co.

The Pittsburg Foundry & Mfg. Co., Pittsburg, has fitted up a plant on South 21st street for foundry use and is now manufacturing heating and gas stove castings. The capital stock will shortly be increased from $10,000 to $15,000. J. Davis, Uniontown, Pa., is president, and J. J. Goldsmith, secretary.

The Acme Pattern Works, Buffalo, has been absorbed by the Frontier Iron Works of the same place.

New Construction.

Benj. Middleditch, Detroit, Mich., contemplates the erection of an iron foundry with a molding floor, 60 x 120 feet.

The Rock Island Mfg. Co., Rock Island, Ill., contemplates the addition of a plating department and would like to receive catalogs from manufacturers of platers' supplies.

The Vulcan Iron Works, New Britain, Conn., will be extended by the erection of a two-story building, 40 x 120 feet. This concern is engaged in the manufacture of gray iron and malleable castings.

The Comstock-Wellman Bronze Co., Cleveland, recently organized with $25,000 capital, to engage in the manufacture of brass, bronze and aluminum castings, has secured a site at 6017 Superior av. and will at once begin the erection of a plant, 50 x 100 feet.

The Maddox Foundry & Machine Co., Archer, Fla., will erect an addition to its pattern shop, 30 x 40 feet.

Contracts for the building and equipment for the addition to the plant of the Acme Steel & Malleable Iron Works, Buffalo, have recently been awarded. This extension will be 147 x 260 ft., one and two stories high.

The Laidlaw-Dunn-Gordon Co., Cincinnati, contemplates the erection of a pattern shop, 50 x 20 feet.

The Phelps street foundry of the Lloyd-Booth department of the United Engineering & Foundry Co., Youngstown, O., will be abandoned within a few months, and the machine shop will be enlarged to include the present foundry building. The foundry work will thereafter be confined to the Oak street department, which will probably be extended at an early date.

The Moore-Jones Brass Co., St. Louis, will erect a new one-story foundry, which, together with the equipment, will cost approximately $30,000.

The Oscar Barnett Foundry Co., Newark, N. J., will erect a new plant at Lyons and Woolsey avenues, at a cost of approximately $50,000. The works will include two foundry buildings, pattern storage building, forge and machine shops, cleaning and polishing departments, power house and office buildings.

The U. G. Augustine Mfg. Co., 451 West Forty-sixth street, Los Angeles, Cal., Contemplates the erection of a brass foundry for the manufacture of plumbers' supplies.

The Buffalo Foundry & Machine Co., Buffalo, will erect a machine shop north of its present foundry at a cost of approximately $200,000. The building will be of steel and concrete construction, with traveling cranes in all of the bays and galleries. The cranes will be of sufficient capacity to lift sections weighing as high as 200 tons each. The entire plant will be operated by Niagara Falls power.

The Cradford & McCrunnion Co. will erect a foundry at Brazil, Ind., for the manufacture of brass castings for pumps.

The Hupp-Holloran Foundry Co. has been organized at Detroit to engage in the manufacture of castings for motor cars, and both gray iron and brass shops will be erected. The officers of the company are: R. C. Hupp, president; J. H. James, vice president and general manager; L. G. Hupp, secretary and treasurer, and John T. Holloran, superintendent.

The M. Rumely Co., Laporte, Ind., will erect a new foundry, 220 x 320 feet, for the

production of gray iron and semi-steel castings. The raw material storage yard will be entirely enclosed and will cover an area, 75 x 350 feet. The equipment of the foundry will consist of one 48-inch and two 60-inch cupolas, and the shop will be divided into five bays, four of which will be 40 feet wide, and the main bay 60 feet wide, all 320 feet long. The foundry will be amply provided with cranes, both traveling and jib, to facilitate the handling of molds, flasks and castings in every part of the foundry. The building will be of reinforced concrete construction.

George Cotter & Son, South Bend, Ind., manufacturers of electric specialties, will add a gray iron foundry this spring.

Albert Steinfeld and Manuel King contemplate the erection of a foundry and machine shop at Tucson, Ariz. The machine shop will be 40 x 66 feet and the foundry, 40 x 40 feet.

The American Radiator Co. is erecting a new foundry at Springfield, O.

The American Car & Foundry Co. contemplates the erection of another foundry at Detroit.

The Williams Foundry & Machine Co., Cumberland, Md., will erect a foundry, 25 x 90 feet, with an ell, which will be used as a machine shop, 25 x 55 feet.

The Rome Soil Pipe Co., Rome, Ga., will erect a new plant, 130 x 150 feet.

The Minnesota Stove Works, Shakopee, Minn., will be extended by an addition, 80 x 150 feet.

George Guild, Houston, Tex., is having plans prepared for a new plant to consist of a foundry, machine and blacksmith shops.

The Northern Foundry & Machine Co. will erect a pipe foundry at Winnipeg, Can.

Balke & Co., Louisville, Ky., will erect a foundry, 48 x 130 feet.

The A. B. C. Castings Co., Cleveland, has been organized with $100,000 capital to engage in the manufacture of aluminum and brass castings. A site, 70 x 574 feet has been purchased at Carnegie avenue and East Sixty-fifth street, on which a plant will be erected, 70 x 324 feet. The melting equipment will consist of nine pit furnaces, coke-fired, and three gas-fired aluminum furnaces. Five core ovens will be installed, and the melting equipment as well as these ovens will be furnished by the J. D. Smith Foundry Supply Co., Cleveland. The contract for the other foundry equipment, including flasks, molding tubs, etc., was placed with the S. Obermayer Co., Cincinnati. Ground has already been broken for the plant, which will probably be placed in operation in May. Temporary offices have been established at 146 Arcade. The officers of the company are as follows: I. Levy, president; T. L. Johnson, vice president; A. D. Levy, secretary and treasurer, and H. E. Behr, general manager.

The Milwaukee Malleable & Gray Iron Works, Layton Park, Milwaukee, has awarded a contract for a new foundry, 60 x 80 feet.

The D. T. Williams Valve Co., Cincinnati, will erect a new plant, 50 x 227 feet, of concrete construction, four stories high.

The Powhattan Brass & Iron Works, Charleston, W. Va., is erecting an addition to its foundry, 42 x 60 feet. This concern manufactures brass goods and is doubling its furnace capacity.

The J. S. Rowell Mfg. Co., Beaver Dam, Wis., will erect two new buildings, one of which will be used to increase the capacity of the foundry.

The O. M. Edwards Co., Syracuse, N. Y., manufacturer of hardware specialties, steel filing cabinets, office furniture, etc., is extending its line by the addition of a complete line of valves. At the present time they are made in brass only, but in the near future this concern will engage in their manufacture in iron and steel.

The Peerless Manufacturing Co., Louisville, will erect a new foundry, 100 x 200 feet.

The Walworth Run Foundry Co., Cleveland, will erect a new plant at an estimated cost of $20,000.

The Griffin Wheel Co., Chicago, has purchased a site of 17 acres in Salt Lake City, on which a foundry for the manufacture of gray iron car wheels will probably be built.

Weaver & Wittle, Lebanon, Pa., will erect a foundry, 50 x 100 feet, for the production of gray iron, brass and aluminum castings.

The Sterling Foundry Co., Sterling, Ill., will erect a new foundry, 40 x 195 feet.

Campbell & Wyandt, Muskegon, Mich., lessees of the foundry of the Racine Boat Mfg. Co., Muskegon, Mich., will erect a new foundry this spring at Muskegon Heights, Mich.

The American District Steam Co., North Tonawanda, N. Y., will erect a new foundry and machine shop, 240 x 250 feet.

The Wilmington Malleable Iron Co., Wilmington, Del., is building an addition to its foundry, 210 x 230 feet.

The Marseilles Mfg. Co., Marseilles, Ill., has purchased a tract of land containing 10 acres at East Moline, Ill., upon which a new plant will be erected. The works will include a steel foundry, 80 x 250 feet.

The Quick Meal Stove Co., St. Louis, will receive bids on May 1 for the erection and equipment of a stove foundry containing 20,000 square feet of floor space.

Headford Bros. & Hitchens, Waterloo, Ia., gray iron founders, will double the capacity of their plant by the erection of an addition to their foundry, 100 x 400 feet. Another cupola will also be installed.

The New Method Stove Co., Mansfield, O., has purchased the property of the S. N. Ford Lumber Co., including three acres of land and two fireproof buildings. This property will be used for extensions to the New Method Co.'s plant.

The Walworth Run Foundry Co., Cleveland, will enlarge its plant by the erection of an addition to its foundry, 140 x 250 feet. A cupola, blower, molding machines and other foundry equipment will be installed.

H. L. Aiken, formerly connected with the Seaboard Steel Casting Co., Chester, Pa., will erect a crucible steel casting plant at 800 Canal Road, Cleveland. It will be operated under the firm name of the Crucible Steel Castings Co. Four 8-pot furnaces will be installed.

Work on the erection of the new plant of the Standard Sanitary Mfg. Co., which will be built in Toronto, has already been commenced. A group of six buildings of steel and reinforced concrete construction is now under way, including an annealing house, 60 x 150 feet; enamel mixing building, three stories high, 65 x 50 feet; warehouse, 65 x 200 feet, six stories high; pattern building, four stories high, 64 x 130 feet. Plans for the foundry and cleaning department have not as yet been completed. Frank Painter, formerly located at Pittsburg, will be placed in charge of the Toronto branch.

Construction work has been commenced on the new foundry of the American Radiator Co., Chicago, which will be built at Kansas City, Mo. It will be located on a 16-acre tract north of Twelfth street, between the Missouri Pacific and the Kansas City railroads. The buildings will cover approximately five acres, and the cost of the plant is estimated at $500,000. The location will afford excellent shipping facilities, and the plant will be equipped for the manufacture of boilers and radiators. The Kansas City office of the American Radiator Co. is in charge of M. J. Beirn Jr., 342 East Eighth street.

The Moore Bros. Foundry & Machine Co., Riverton, N. J., has been organized to take over the business now conducted by L. H. Moore Sr., and L. H. Moore Jr., under the firm name of Moore Bros. at Riverside, N. J. A site at West Palmyra Station, which is only one mile from Riverton, has been purchased, and upon this a new foundry building is being erected, 31 x 100 feet. The plant will be modernly equipped for the production of gray iron and brass castings. A traveling crane has been installed, as well as a pneumatic elevator to the charging floor. The engine and cupola rooms are in a separate building adjoining the foundry. It is the intention to erect machine and pattern shops in the near future. The officers of the company are Alfred Smith, president; L. H. Moore Sr., vice president, and Alfred W. Smith, secretary and treasurer.

The Standard Foundry Co., Longueuil, Quebec, has been reorganized under the name of the Standard Foundry & Machinery Co. E. Prevost is president and S. Whiteside, secretary and treasurer.

The Globe Metal Co., Chicago, refiner of brass and copper, has purchased a tract of land on Clybourne avenue, on which will be erected a plant similar to the one now operated at 1334 West Lake street.

The Cream City Foundry Co., Milwaukee, recently organized, has awarded a contract for a building, 70 x 160 feet.

The National Car Wheel Co. has purchased a 2½ acre site on the Lake Shore railroad at West 106th street, Cleveland, and will at once begin the erection of a new car wheel plant to replace its present foundry on Carter road.

The Standard Electric Works, Racine, Wis., is having plans prepared for a new foundry, 38 x 96 feet.

The Dodge Mfg. Co, Mishawaka, Ind., is erecting an addition to its foundry, 360 feet long. This concern now has under construction a warehouse of reinforced concrete, 112 x 256 feet, four stories and basement, which will be used for the storage of stock goods.

The Banner Iron Works, St. Louis, is contemplating the erection of a new department for the production of converter steel castings. The newly elected officers of this concern follow: W. T. Koken, president; H. A. Frielingsdorf, vice president and general manager, and E. C. Koken, secretary and treasurer.

The F. I. A. T. Automobile Co. is erecting a brass foundry at Poughkeepsie, N. Y., for the production of brass castings for its line of automobiles, which will be built at this plant.

The Elkhart Brass Mfg. Co., Elkhart, Ind., manufacturer of brass goods, will erect a new plant, 160 x 226 feet.

The Birmingham Iron Foundry, Derby, Conn., manufacturer of chilled and sand rolls, rubber mill and heavy machinery castings will build an addition to its foundry, 66 x 88 feet. This will be devoted to light and molding machine work.

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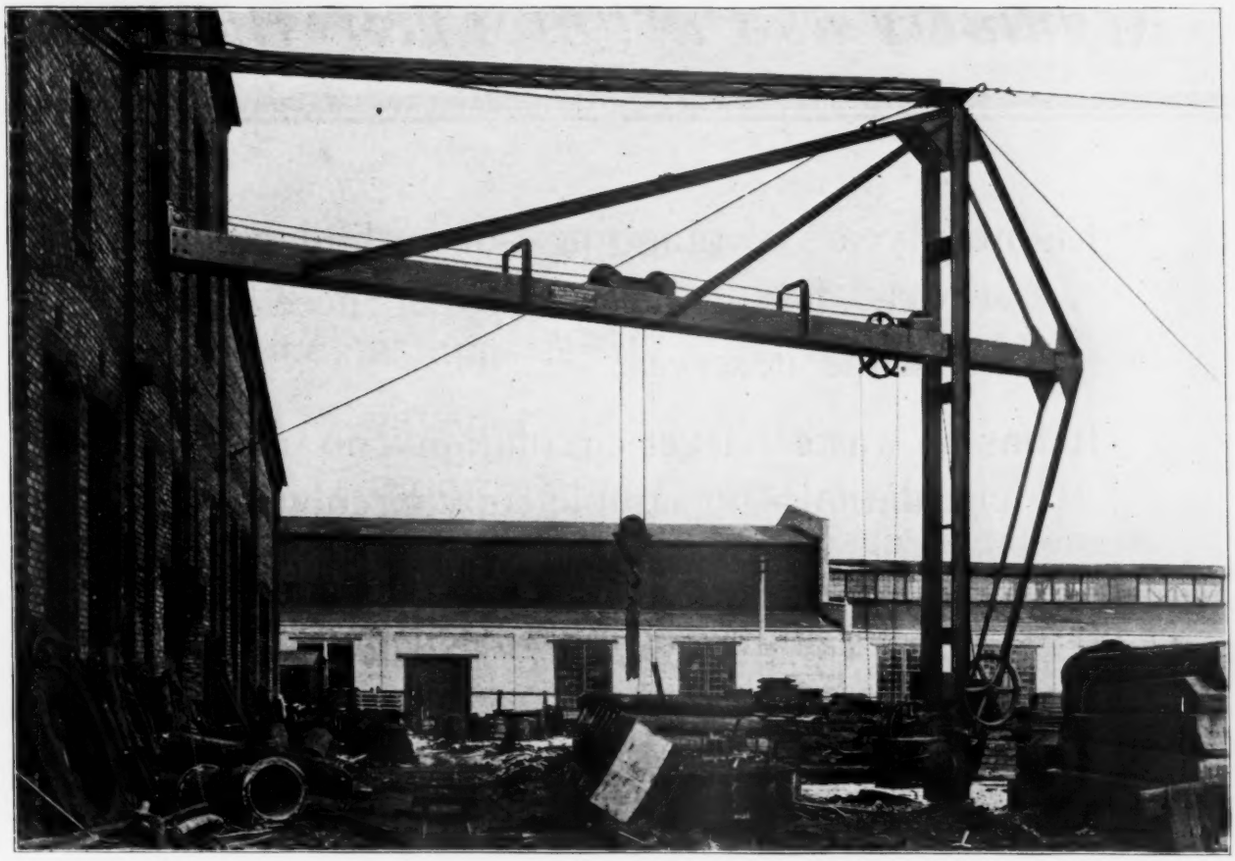
AND CRANES OF ALL TYPES FOR ALL PURPOSES



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Over 90% of the Men in Charge of Foundries in this Country Read THE FOUNDRY Regularly as Part of Their Business

Eighteen years of plugging—of faithful, efficient, service—has made this paper necessary to the trade it serves.

It has no waste-basket circulation—no unopened circulation—no sample copy circulation—no imitation circulation of any sort.

It is paid for and welcomed each month by the men responsible for results in foundries, everywhere.

They read it as part of their business.

You should advertise in it as part of yours.

For adequate use of its advertising pages will surely give the sales end of your business a decided boost.

The paper which continues to carry, year after year, most of the business in its line, must be the most profitable advertising medium for that line.

Its advertising space is far better and cheaper than any other known method or medium for reaching the right men in the foundry business.

Back of the Bulk of Foundry Equipment and Supplies Bought in this Country are the Readers of this Paper

Advertisers can absolutely cover the buyers of foundry supplies and equipment by the use of one medium—THE FOUNDRY.

Just one advertising bill to pay.

The concentration of your advertising in THE FOUNDRY is the one sure, safe, efficient way to get the best results.

You badly dilute the strength of your selling proposition when you administer your advertising in small, weak, scattered doses.

Select the right medium—then use sufficient space to give your selling argument its full force.

The Tabor Mfg. Co., of Philadelphia, have tried it, and they know.

Their advertising manager, Mr. W. H. Taylor, writes:

> "We feel that THE FOUNDRY covers about 90% of the foundry field, and the results from our advertisements have been commensurate therewith. In view of these facts, the most expedient method of acquainting foundrymen with our wares is to use unlimited space, say 2, 4 or 6 pages as may be necessary to comprehensively describe the Tabor line of foundry molding machines. Your statement about 'putting your eggs in *one* basket,' provided *that* basket is THE FOUNDRY, will be conducive of desired results to its followers."

This is not a testimonial—it's facts, proof, evidence—that foundry supplies and equipment, no matter what, can be profitably advertised in THE FOUNDRY as nowhere else.

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